Effect of yeast-based selenium on blood progesterone, metabolites and milk yield in Achai dairy cows

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ABSTRACT

The aim of present study was to find the influence of organic selenium (Se) on blood progesterone, metabolites and milk production in Achai dairy cows. A total of 45 cows were divided into three groups. One of these was control group. The 2nd and 3rd group were supplemented with yeast based Se at the rate of 0.3 and 0.4 mg/kg dry matter intake (DMI) respectively from the start of eighth month of pregnancy until parturition. Animals supplemented with organic Se at the rate of 0.3 and 0.4 mg/kg had significantly (p < .05) higher serum progesterone (P4) concentration (2.98 ng/mL) and milk production (3.94 L/day) respectively, exhibiting 24.8% higher milk production than the control group. Serum cortisol level was significantly lower (0.42 ug/dL) in animals supplemented with yeast based Se at the rate of 0.4 mg/kg DMI. Concentration of serum glucose, triglycerides and cholesterol did not differ among the groups. In conclusion, supplementation of yeast based Se improved the progesterone concentration, milk yield and reduced the stress in Achai dairy cattle.

HIGHLIGHTS

- Organic selenium (Se) improved milk yield in Achai cows
- Organic Se reduced stress in Achai cows
- Organic Se had no effect on blood metabolites

Introduction

Achai is a small cattle breed found in Khyber Pakhtunkhwa and well adapted to the local environmental conditions and scarce forages resources. Achai cows have very low nutritional requirements because of the small body size, therefore, it can flourish under scarce availability of fodder (Khan et al. 2008). The calving interval (461.89 ± 20.23 days) and milk yield (813.07 ± 113.3 L per lactation) of this breed is less than many commercial dairy cows (Hayaz et al. 2014). Due to the adaptability to the scarce resources, Achai cows are quite popular among the local farmers. Although multiple factors are responsible for the declining fertility in dairy cows, improving the function of corpus luteum (CL) is one of the focuses of recent studies (Kamada 2017; Saqib et al. 2018). It was found that reduced level of progesterone (P4) in plasma during the ovulatory follicles’ growth is associated with decreased conception rate (Pursley and Martins 2011) and poor survival rate of embryo during the early stages of pregnancy (Inskeep 2004).

Selenium (Se) is a key micro mineral responsible for important functions. It has been suggested that dairy cattle requires Se at the rate of 0.3 mg per kg dry matter intake on daily basis (Mehdi and Dufranse 2016). It has also been reported that yeast based Se improved the activity of CL by enhancing postpartum plasma P4 concentration (Kamada 2016). Organic Se is retained in higher concentration in the tissues than inorganic form and ensures sufficient bioavailability for the prevention of diseases in cattle (Wilde 2006). Animals are usually deficient in Se since forages are largely lower in this important trace element (Ahmad et al. 2009). Therefore, Se supplementation is advised to ensure minimum level of intake (Lu and Holmgren 2009). In addition, it has also been reported that organic Se is superior to the inorganic form in dairy cattle (Slavik...
et al. 2008). The aim of the present study was to find the effect of organic Se on blood progesterone, metabolites and milk production of Achai cows.

**Materials and methods**

This study was approved by the local committee of Use and Care of Animals at The University of Agriculture, Peshawar, Pakistan.

**Animal selection and experimental design**

A total of 45 Achai cows having similar average body condition score, weight and parity were divided randomly into three groups. Each group was comprised of 15 pregnant animals. One group served as a control while other two groups were supplemented with organic Se at the rate of 0.3 and 0.4 mg/kg dry matter intake (DMI) respectively in the last month of the pregnancy. Organic Se was fed in the form of organic yeast Se (Altech Company, Sel-plex). Selenium yeast contained 2000 ppm Se, therefore, 0.9 and 1.2 g was mixed with the feed to obtain final concentration of 0.3 and 0.4 mg/kg Se respectively. Cows were fed total mixed ration (TMR) to meet the production requirement of NRC (2001). The amount offered to each cow was adjusted weekly according to their milk production. The representative composition of TMR during dry and lactation period is given in Table 1. Water was provided ad libitum.

**Blood collection**

A quantity of 5 mL of blood was collected from each cow (from jugular vein) on weekly basis until 7th week postpartum in heparinised tubes early in the morning before feeding and centrifuged for 10 minutes at 3000 rpm. Serum was preserved at −20 °C until analysed.

**Determination of blood metabolites**

Blood glucose, cholesterol and triglyceride were determined with the help of commercial kits (MTD Diagnostic, Italy) using spectrophotometer (IRMECO Model U2020, IRMECO QmbH, Geesthacht, Germany). Blood progesterone was determined with the help of ELISA Kit (Biocheck, USA).

**Determination of milk yield**

Milk yield (L/day) of each cow was determined on the daily basis twice a day for a period of three months.

**Statistical analysis**

Data were statistically analysed with the help of Analysis of Variance (ANOVA) for repeated measures (SAS Institute, Cary, NC, USA) using least significant difference (LSD) as post hoc test. The experimental unit was the individual animal. The results were presented as the mean and pooled standard error of mean (SEM). p value less than .05 was considered statistically significant.

**Results**

Mean serum P4 concentration at different postpartum weeks is given in Table 2. It is clear that group and week significantly affected serum P4 concentration (p < .05). Mean serum P4 concentration was significantly higher in Se fed groups compared to the control group. The interaction of group and week was non-significant (p > .05). Mean serum glucose concentration at different postpartum weeks is given in Table 3. The results show that effect of group, week and their interaction was non-significant (p > .05). Numerically, higher

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**Table 1.** Average representative composition of total mixed ration during the dry and lactation period.

| Diet composition (dry matter), % | Dry period | Lactation |
|---------------------------------|------------|-----------|
| Wheat                           | 30.000     | 35.000    |
| Barley                          | 23.000     | 26.000    |
| Soya hulls                      | 12.340     | 12.340    |
| Wheat bran                      | 3.000      | 3.000     |
| Alfalfa                         | 18.430     | 6.210     |
| Salt                            | 0.500      | 0.500     |
| Limestone                       | 2.400      | 4.500     |
| Molasses                        | 10.260     | 12.350    |

**Table 2.** Mean ± SE serum progesterone concentration (ng/mL) at different postpartum weeks in control and organic Se treated Achai cows.

| Postpartum week | Control 0.3 mg/kg DMI | 0.4 mg/kg DMI SEM |
|-----------------|------------------------|-------------------|
| Week 1          | 1.86                   | 2.16              | 0.05              |
| Week 2          | 2.49                   | 3.01              | 0.07              |
| Week 3          | 2.72                   | 3.16              | 0.22              |
| Week 4          | 2.41                   | 3.43              | 0.23              |
| Week 5          | 2.54                   | 2.91              | 0.27              |
| Week 6          | 2.60                   | 3.34              | 0.34              |
| Week 7          | 2.58                   | 2.87              | 0.34              |
| Overall group mean | 2.46a                 | 2.98a              | 0.11              |

*a, bMean values in a row differ significantly (p < .05).

p Value: Group = .005, Week = .0039, Group×week = .888.

DMI: dry matter intake; SEM: standard error of mean.
daily milk production (of animals) have a significant effect on the average performance in cows. Our results are in agreement with Kamada (2016) who found that supplementation of cows with Se at the rate of 0.3 mg/kg DMI significantly enhanced their plasma P4 concentration. However, our result contradicts with the finding of Ganie et al. (2014) who found no significance difference between plasma P4 concentration probably due to the lower dose of Se (0.2 mg/kg). From the current study, it could be inferred that due to the antioxidant function of Se, the peroxides in CL were neutralised through higher production of Se based glutathione, leading to the improved secretion of P4 (Kamada 2016).

In the present research, Se supplementation did not affect serum glucose concentration in Achai dairy cows. In the published literature, there is a much discrepancy on the metabolic response of dairy animals supplemented with Se. For example, contrary to our findings, Singh et al. (2002) reported low concentration of glucose in blood of buffalo calves offered wheat straw having high Se (8.54 mg/kg DMI). On other hand, Nayyar et al. (2003) found that blood glucose level in anoestrous buffalo heifers subjected to vitamin E-Se was significantly higher than control group. Kamada (2016) also observed no significant rise in plasma glucose level in Holstein cows which were fed yeast based Se at the rate of 0.3 mg/kg DMI. The discrepancy in the results may be due to the nature of Se, dose, duration and other experimental protocols.

### Discussion

In the current study, we reported that Se supplementation significantly increased serum P4 concentration in supplemented groups compared to the control. Animals having elevated postpartum plasma P4 have better conception rate (Staples et al. 1998; Ihsanullah et al. 2017). So we advocate that enhancing P4 by Se supplementation improved the reproductive concentration was recorded for 0.4 mg/kg DMI after week 7, while lower concentration was recorded for control group after week 1. Mean serum cholesterol concentration at different weeks postpartum is given in Table 4. The table shows that postpartum weeks have significant effect on serum cholesterol concentration (p < .05). Effect of group as well as its interaction with postpartum week were non-significant (p > .05). Mean serum triglycerides concentration at different weeks postpartum is given in Table 5. It is clear that effect of group, postpartum week and their interaction was non-significant (p > .05).

Mean serum cortisol concentration at different weeks postpartum is given in Table 6. It is clear from the table that group of animals and postpartum weeks had a highly significant effect on serum cortisol concentration (p < .001). Group of animals supplemented with Se at the rate of 0.4 mg/kg DMI had significantly lower serum cortisol concentration than the rest of the two groups. Interaction of groups and postpartum weeks was non-significant (p > .05). Mean average daily milk production at different weeks postpartum is given in Table 7. It is clear from the results that group of animals have a significant effect on the average daily milk production (p < .001). Group of animals supplemented with Se at the rate of 0.3 mg/kg DMI had significantly higher average daily milk production than the rest of the groups. Postpartum weeks and its interaction with groups was non significant (p > .05; Table 7).

### Table 3. Mean ± SE serum glucose concentration (mg/dL) at different postpartum weeks in control and organic Se treated Achai cows.

| Postpartum week | Control | 0.3 mg/kg DMI | 0.4 mg/kg DMI | SEM |
|-----------------|---------|---------------|---------------|-----|
| Week 1          | 82.53   | 99.50         | 88.50         | 6.41|
| Week 2          | 94.93   | 92.26         | 93.90         | 3.34|
| Week 3          | 95.30   | 98.01         | 105.41        | 6.90|
| Week 4          | 97.08   | 104.94        | 99.47         | 5.11|
| Week 5          | 95.46   | 100.68        | 97.65         | 4.77|
| Week 6          | 92.65   | 104.36        | 106.64        | 7.23|
| Week 7          | 95.03   | 94.10         | 107.41        | 8.19|
| Overall group mean | 93.28 | 99.12         | 99.85         | 3.33|

*p Value: Group = .231, Week = .579, Group*week = .888.
DMI: dry matter intake; SEM: standard error of mean.

### Table 4. Mean ± SE serum cholesterol concentration (mg/dL) at different postpartum weeks in control and organic Se treated Achai cows.

| Postpartum week | Control | 0.3 mg/kg DMI | 0.4 mg/kg DMI | SEM |
|-----------------|---------|---------------|---------------|-----|
| Week 1          | 116.65  | 121.83        | 111.74        | 11.23|
| Week 2          | 117.65  | 117.02        | 100.82        | 7.87 |
| Week 3          | 120.77  | 140.86        | 113.19        | 12.34|
| Week 4          | 121.98  | 144.17        | 133.52        | 10.98|
| Week 5          | 134.06  | 147.47        | 135.77        | 11.45|
| Week 6          | 127.43  | 154.48        | 147.61        | 13.65|
| Week 7          | 141.47  | 157.82        | 147.83        | 12.34|
| Overall group mean | 125.72 | 140.52        | 127.21        | 6.74 |

*p Value: Group = .15, Week = .29, Group*week = .84.
DMI: dry matter intake; SEM: standard error of mean.

### Table 5. Mean ± SE serum triglycerides concentration (mg/dL) at different postpartum weeks in control and organic Se-treated Achai cows.

| Postpartum week | Control | 0.3 mg/kg DMI | 0.4 mg/kg DMI | SEM |
|-----------------|---------|---------------|---------------|-----|
| Week 1          | 15.71   | 16.82         | 16.88         | 3.56 |
| Week 2          | 22.11   | 14.25         | 17.28         | 2.34 |
| Week 3          | 19.45   | 17.92         | 22.08         | 12.67|
| Week 4          | 22.25   | 17.68         | 18.83         | 4.56 |
| Week 5          | 18.04   | 14.24         | 23.64         | 13.76|
| Week 6          | 22.88   | 21.27         | 24.89         | 17.65|
| Week 7          | 21.49   | 16.51         | 19.14         | 4.11 |
| Overall group mean | 20.28 | 16.96         | 20.39         | 5.67 |

*p Value: Group = .107, Week = .394, Group*Week = .937.
DMI: dry matter intake; SEM: standard error of mean.
In the present study, Se supplementation did not significantly affect serum cholesterol and triglycerides in the control and treated cows. Our results contradicted with Bunglavan et al. (2014) who found a lower in the control and treated cows. Our results contra-

Additionally, the non-significant effect of supplementation compared to the control. Contrary to our result, Reis et al. (2012) found that Se (0.5 mg/kg) supplementation does not have any effect on cholesterol and triglycerides in dairy cows. Antunović et al. (2014) who did not report any significant difference in blood total cholesterol and triglycerides between control and Se (0.3 mg/kg) fed lambs. Also, the non-significant effect of supplementation with Se on triglycerides was in agreement with the research conducted in farm animals (Moty and Kassab 2012; Ziaei 2015; Kamada 2016).

In our experiment, Se supplementation at the rate of 0.4 mg/kg DMI decreased serum cortisol concentration significantly as compared to the rest of the two groups. In addition, 0.3 mg had no significant effect compared to the control. Contrary to our result, Reis et al. (2012) found that Se supplementation at the rate of 3.6, 5.4 and 6.4 mg per animal per day does not affect serum cortisol concentration in cows. Stress activates hypothalamic–pituitary–adrenal axis which signals adrenal gland to produce cortisol (Ihsanullah et al. 2017). Increased lipid peroxidation and decreased antioxidant activity result in complications (Khan 2011). During early lactation, negative energy balance is a major factor for oxidative stress (Roche et al. 2000), which in turn results in the expression of inflammatory cytokines and secretion of cortisol (Sathy et al. 2007; Sordillo 2013). Se is a potent anti-

| Table 6. Mean ± SE serum cortisol concentration (µg/dL) at different postpartum weeks in control and organic Se-treated Achai cows. |
|------------------|----------------|----------------|-----------------|----------------|
| Postpartum week  | Control        | 0.3 mg/kg DMI  | 0.4 mg/kg DMI   | SEM            |
| Week 1           | 0.51           | 0.45           | 0.43            | 0.02           |
| Week 2           | 0.44           | 0.44           | 0.42            | 0.01           |
| Week 3           | 0.47           | 0.44           | 0.36            | 0.01           |
| Week 4           | 0.43           | 0.46           | 0.36            | 0.02           |
| Week 5           | 0.49           | 0.49           | 0.46            | 0.02           |
| Week 6           | 0.50           | 0.48           | 0.46            | 0.01           |
| Week 7           | 0.46           | 0.44           | 0.45            | 0.01           |
| Overall group Mean | 0.47a         | 0.46a          | 0.42b           | 0.02           |

Mean values within a row with different superscript differ significantly (p < .05).

*p Value: Group = .000, Week = .000, Group × Week = .118.

DMI: dry matter intake; SEM: standard error of mean.

| Table 7. Mean ± SE Average daily milk production (L/day) at different postpartum weeks in control and organic Se-treated Achai cows |
|------------------|----------------|----------------|-----------------|----------------|
| Postpartum week  | Control        | 0.3 mg/kg DMI  | 0.4 mg/kg DMI   | SEM            |
| Week 1           | 3.680          | 3.700          | 3.200           | 0.140          |
| Week 2           | 4.070          | 4.080          | 3.420           | 0.200          |
| Week 3           | 2.800          | 3.820          | 2.450           | 0.190          |
| Week 4           | 3.390          | 4.130          | 2.840           | 0.150          |
| Week 5           | 3.900          | 4.030          | 3.340           | 0.280          |
| Week 6           | 3.590          | 4.000          | 2.880           | 0.350          |
| Week 7           | 3.320          | 4.080          | 3.400           | 0.240          |
| Week 8           | 2.960          | 4.030          | 3.360           | 0.330          |
| Week 9           | 3.090          | 4.040          | 3.210           | 0.150          |
| Week 10          | 2.650          | 3.760          | 3.000           | 0.320          |
| Week 11          | 2.800          | 3.970          | 2.660           | 0.310          |
| Week 12          | 2.740          | 3.980          | 2.680           | 0.320          |
| Week 13          | 2.330          | 3.640          | 2.320           | 0.310          |
| Overall group mean | 3.154b         | 3.937a         | 2.981b          | 0.100          |

**Mean values in a row differ significantly (p < .05).**

*p Value: Group = .000, Week = .115, Group × Week = .995.

DMI: dry matter intake; SEM: standard error of mean.
improve the milk production compared to the control cows. It seems that two different levels of Se is working for managing stress level (cortisol concentration) and milk production. In addition, higher milk yield was recorded in cows fed 0.3 mg Se compared to 0.4 mg. We could not find any plausible reason of this result from the published literature; however, it seems that the higher level of Se had adverse effect on the milk yield in this breed of cows.

Conclusions

Based on these results, it is concluded that supplementation of yeast-based Se supplementation promoted the postpartum progesterone concentration, reduced hormonal stress and improved milk production in dairy Achai cows. In addition, the blood metabolites were not affected by the current level of Se.

Disclosure statement

No potential conflict of interest was reported by the authors.

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