ISSN 1023-1072

Pak. J. Agri., Agril. Engg., Vet. Sci., 2017, 33 (2): 254-263

EFFECT OF DIETARY SELENIUM YEAST SUPPLEMENTATION ON PHYSICO-CHEMICAL CHARACTERISTICS OF GOAT MEAT

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ABSTRACT

The current study assessed the influence of selenium yeast (SeY) on some physico-chemical characteristics of goat meat. A total of ten cross- bred goats of 4 months age and 10.5 kg body weight were assigned into two groups, viz. Control and SeY (n=5 each group) and provided only basal diet (control) or basal diet supplemented with SeY at the dose of 0.3 mg/kg feed. The experiment lasted for eight weeks. The results revealed that physical characteristics of meat were not different (P> 0.05) between the groups; however, the meat pH decreased by 0.15 units and the cooking and drip losses were reduced by approximately 11 and 13.5 % in SeY goats as compared to control. The determination of chemical characteristics showed no significant changes (P> 0.05) in the moisture, protein and ash contents, however, the fat content of meat tended to increase (P< 0.097) by 37.5% in SeY compared to that in control. In conclusion, the results of present study showed that most of the physico-chemical properties of meat were not significantly different between the two groups except for fat content which tended to increase in SeY goats compared to control. The increase in fat content was associated with slight decrease in some physical characteristics such as pH, water holding capacity and cooking loss of meat in SeY goats, which suggest that SeY supplementation in the diet of goats slightly improved physico-chemical properties of meat.

Keywords: goat, meat, selenium, selenium yeast

INTRODUCTION

The major sources of meat are cow, buffalo, goat and sheep however, the meat of goat is frequently used in the Middle East, Africa and South Asia including Pakistan. Generally, meat is considered as valuable food for humans providing many essential nutrients such as proteins, vitamins (vitamins A, B12 and E), fat (such as Omega-3 fatty acids) and minerals (Fe, Zn, Se) which are of prime importance for the growth of human body (Schonfeldt and Gibson, 2008). Selenium (Se) shortly after its discovery in 1817 got special attention due to its wide biological role in animals and humans (Burk *et al*., 1976). There are two

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forms of Se i.e. organic and inorganic. The bioavailability of Se sources in tissues vary greatly, i.e. the tissue retention of organic Se is higher than that of inorganic Se (Ku *et al*., 1973). The functional form of selenium is seleinoproteins such as glutathione peroxidase, which form a part of antioxidation system and provides protection against oxidative stress caused by pro-oxidants, normally produced in tissues during oxidative metabolism (Hartlova *et al*., 2009).

Se improves quality characteristics of meat such as nutritive value, flavor impartment and keeping quality. The nutritive value and flavors of meat products are adversely affected by the oxidation reactions which can be prevented by the antioxidant ability of glutathione peroxidase (GSH-Px) (DeVore *et al.*, 1983; Morrissey *et al.,* 1998; Gatellier *et al.*, 2004). Dietary Se increases tissue Se concentration in ruminants (Scholz *et al.*, 1981; Gatellier *et al.*, 2004), which is influenced by the source, the experimental period, Se level in the diet and the species of animal (Grace, 1985). Although Se is present in all tissues in varying levels, but it is abundantly found in the liver, kidneys, and spleen, and to a lesser extent in skeletal muscles, cardiac muscles, intestines, and lungs (Pond *et al*., 1995). The supplementation of Se in ruminant's diets may increase the oxidative stability of their meat. The quality characteristics of meat are affected by oxidative reactions and it has been shown that the antioxidant enzymes (Glutathione peroxides, superoxide dismutase and catalase) provide first line of defense against oxidative agents (Gatellier *et al.*, 2004). The strategy to maintain the meat quality thus involves the reduction of oxidation (Faustman and Cassens, 1989), which can be achieved by the availability of an antioxidant in the meat (Sanchez-Escalante *et al.*, 2001). Keeping in view that the Se supplementation in ruminant diet improves the quality characteristics of meat; the present study was designed to examine the effect of dietary Se supplementation on physico-chemical characteristics of goats of meat.

MATERIALS AND METHODS

Animals, feeding management and experimental design

A total of ten crossbred goats having body weight 10-13 kg and age 3-4 months were used in this study. After an adaptation period of minimum two weeks, goats were assigned into two dietary groups (n=5/group) *i.e.* control and selenium yeast (SeY). All goats received basal diet (mixture of guar hay and concentrate) at the ratio of 60:40. Control group was fed only basal diet whereas SeY group was fed diet supplemented with selenium yeast (Selemax™, Biorigin®, Lençóis Paulista, São Paulo, Brazil @ 0.3 mg/kg.diet). The ingredients of concentrate were ground corn, cottonseed bran, wheat bran which contained 0.035 mg/kg diet of Se. The chemical composition of feed samples was analyzed by the method as described by Malhi *et al*. (2013). The metabolizable energy (ME) content (MJ/kg DM) was 14.87 and 8.76 for concentrate and hay, respectively. The ME contents of feed samples were analyzed as reported by Moolchand *et al*. (2013). The experiment lasted for 8 weeks.

Slaughtering of animals and collection of meat samples

Animals were slaughtered at the end of feeding trial and the meat samples were collected from longissimus dorsi (LD) muscle to determine the quality characteristics. The LD muscle was excised from the carcasses, between the 8th

and 11th thoracic vertebrae and the excess fat was removed from the muscles before any physical and chemical analyses were carried out.

Determination of physico-chemical characteristics

A piece of meat (10 g) was homogenized in distilled water (90 ml) and the pH was determined by pH meter (Ockreman, 1985). For the determination of the water holding capacity (WHC), a piece of meat (8 g) was mixed in 0.6 M sodium chloride solution (12 ml) in the test tube. After centrifugation of sample (4 ^{0}C) for 15 min at 10,000 rpm, the supernatant was collected and WHC was measured and expressed in percentage (Wardlaw *et al*., 1973). The procedure of Kondaiah *et al.* (1985) was followed for the determination of cooking loss of meat. Meat sample (20g) was taken in a polythelene bag and heated for 1 hr in a water bath at an internal temperature of 72^{0}C. Cooked mass was taken out from the bag, cooled and then weighed to measure the weight loss. The method of Sen *et al.* (2004) was used to measure the drip loss. Meat sample (50g) was placed in polythylene bag with sealad cover and refrigerated (4^{0}C) for 24 hours. It was then wiped and dried with filter paper and weighed. The difference among actual weight of sample before and after refrigeration was assumed as drip loss. Chemical characteristics of meat were after determined. The chloroform: methanol mixture (1:1 v/v) was used to extract lipid (Hanson and Olley, 1963) and the total lipids were gravimetrically measured.

Statistical analysis

Data was analyzed by Student's t test using statistical software SPSS12.0 (StatSoft, Tulsa, OK, USA). The values were presented as Mean ± SEM and the significance was considered at $P< 0.05$.

RESULTS

The physical properties of goats meat are depicted in Figure 1. The pH of meat in SeY (5.59 ± 0.15) was not different ($P> 0.05$) than that of control (5.35 ± 0.07) however; the pH was decreased by 0.15 units in SeY goats compared to control. The water holding capacity (WHC) of meat in control and SeY groups (79.5 ± 2.87 and 76 ± 4.10%) did not vary significantly ($P> 0.05$) between the two groups. The cooking loss of meat in SeY goats (40.41 ± 1.51%) revealed non-significant difference ($P> 0.05$) as compared to control (36.34 ± 1.91%). Similarly, the drip loss of meat chilled from post-slaughter period to 24 h in control (2.51 ± 0.25) was not significantly different ($P> 0.05$) as compared to SeY (2.21 ± 0.11). However, the cooking and drip losses were reduced by approximately 11 and 13.5% in SeY fed goats than in control.

DISCUSSION

In the previous studies we have shown that dietary Se supplementation improves intestinal morphology in goats (Ahmad *et al*., 2016), and the current study evaluated the effect of Se supplementation in diet on quality characteristics of meat of goats. Meat pH is one of the key determinants which directly or indirectly affects the several other quality characteristics of meat.

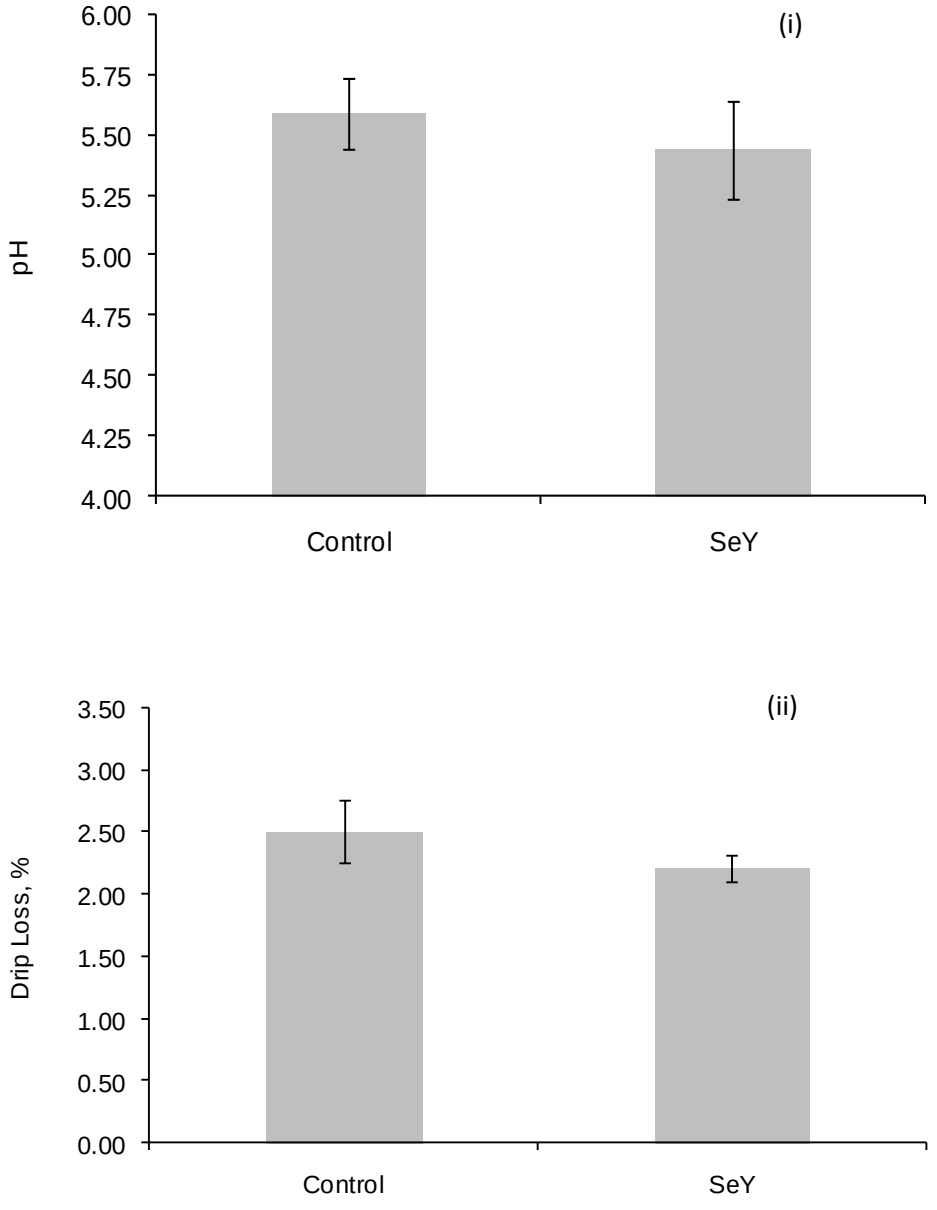

Figure 1 (i) and (ii). Effect of dietary Se supplementation on (i) pH, (ii) Drip loss (%) of fresh meat samples cut from longissimus dorsi (LD) muscle of slaughtered goats

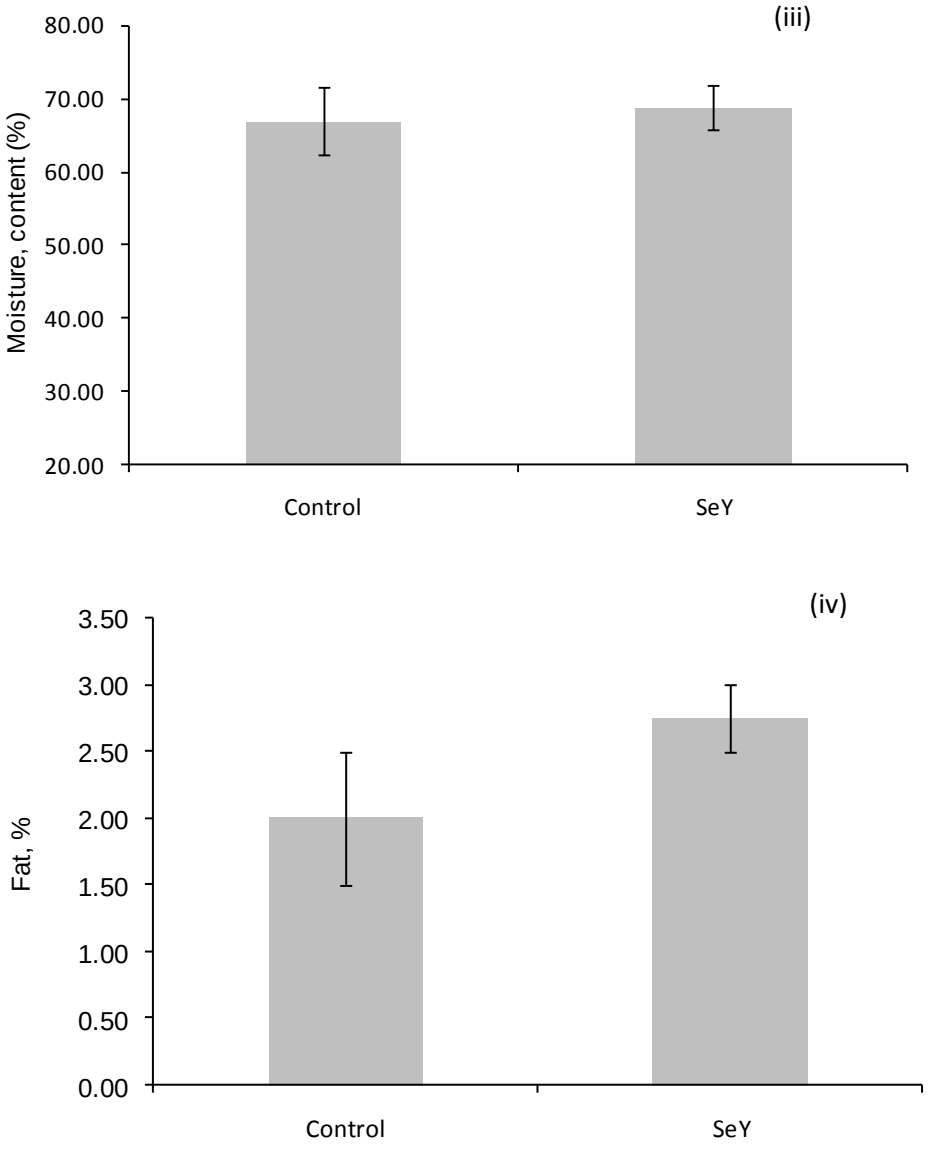

Figure 1. (iii) and (iv). Effect of dietary Se supplementation on (iii) Moisture content (%) and (iv) Fat (%) of fresh meat samples cut from longissimus dorsi (LD) muscle of slaughtered goats

Goats were fed basal diet without selenium supplementation (Control, n=5), Basal diet + selenium yeast at the dose 0.3 mg/kg diet (SeY) for 8 weeks. Values are mean ± SE.

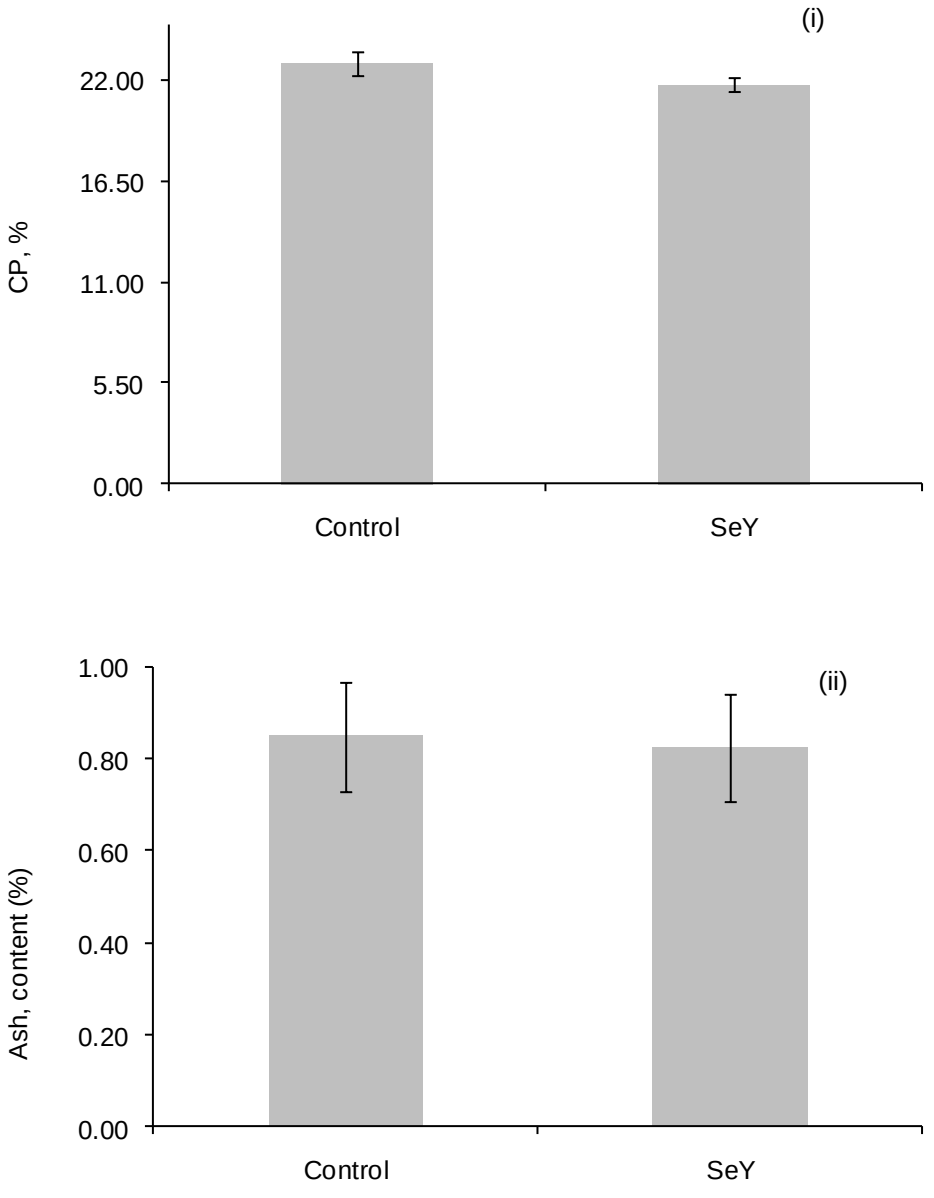

Figure 2. (i) and (ii). Effect of dietary Se supplementation on (i) Crude protein (CP, %) and (ii) Ash content (%) of fresh meat samples cut from longissimus dorsi (LD) of slaughtered goats

The level of maturity of meat is affected by pH and the pH can be categorized into three final ranges: normal (below 5.8), intermediate (above 5.8

upto 6.2) and high (above 6.3) (Hopkings *et al*., 1995). Generally, the meat presents good quality at pH rages between 5.4-5.7. In the present study, the average pH of goat meat (approximately 5.5) was within normal range and did not vary between the groups. Consistent with these results, previous studies have shown no significant effect of selenium yeast supplementation on pH of meat from lamb and calves (Marounek *et al*., 2006; Esterhuyse, 2012; Hernandez-Calva *et al*., 2013). However, the meat pH was slightly lower in goats fed selenium yeast (SeY) supplemented diet than control, which were fed diet without SeY supplementation. In live animal the normal muscle pH values is about 7.1. The extent of decrease in meat pH depends on the concentration of glycogen in the muscle before the slaughter and its conversion into lactic acid in post-slaughter muscle (Immonen *et al*., 2000). In the current study, the decreased pH suggests higher muscle glycogen concentration in SeY treated goats than in control. It seems that glucose uptake and glycogen synthesis increased in muscle cells of SeY goats which may be due to insulin-like effects of selenium in animal body (McNeill *et al*., 1991; Berg *et al*., 1995). Moreover, Arain *et al*. (2010) examined the physical characteristics of meat of Pakistani goats aged below 7 months and showed that pH value ranged between 6.13 and 6.51, which is obviously higher than observed in the present study which is in a range between 5.35-5.59. The difference in these results may be due to breed, sex, environment and other multiple pre- and peri-slaughter factors which are not clear in the study of Arain *et al*. (2010) because they collected meat samples from slaughter house. In the present study, we used female goats and the animals were slaughtered in cold weather in nearby slaughter house without giving much transportation stress. It has been shown that meat obtained from female animals, collected in cold season, and under reduced transportation has comparatively lower ultimate pH (Page *et al*., 2001; Kadim *et al*., 2004; Mounier *et al*., 2006).

In the present study, the dietary Se supplementation showed no significant difference on water holding capacity, cooking loss and drip loss of meat compared to control. In accordance with our results other researchers have shown no significant influence of SeY supplementation on, WHC, cooking loss and drip loss of meat of calves (Marounek *et al*., 2006; Esterhuyse, 2012). Moreover, there is a direct relationship between WHC and pH of meat, which means the higher the final pH, the stronger the binding of water in muscle (Thomas *et al*., 2004). Marounek *et al*. (2006) and Hernandez-Calva *et al*. (2013) showed no influence of SeY supplementation on pH of meat from lamb and calves, which indirectly suggests no change in WHC. However, the WHC of meat from SeY fed goats was slightly lower than that of control, thus the lower values of WHC is consistent with lower pH values of meat from goats fed SeY supplemented diet compared to those fed diet without Se supplementation. In the present study, the moisture, protein and ash contents of meat showed no significant variation between the groups, however, the fat content of meat increased ($P< 0.097$) by 37.5% in SeY compared to that in control. Consistent with our results, Marounek *et al*. (2006) observed no significant effects of selenium supplemented diet on protein, fat and ash contents, however, they observed non-significant increase in fat content of meat by 11.76% from calves fed Se supplemented diet compared to those fed diet without Se

supplementation. Pereira *et al*. (2012) and Netto *et al*. (2013) observed no influence of dietary SeY on fat content, fat thickness and individual fatty acid profile in LD muscle (meat) from cattle. The fat content affects the sensory and keeping properties of meat such as it improves meat palatability and affects texture, juiciness and flavor as well as being important for meat preservation (Webb *et al*., 2005; Webb and O'Neill, 2008). In the present study slight improvement in physical properties of meat is consistent with proportional increase in fat content in selenium fed goats compared to those not fed selenium. The increased fat synthesis in muscles of Se fed goats may be attributed to insulin-like effects of selenium as insulin has been shown to have anabolic effects on fat (McNeill *et al*., 1991; Berg *et al*., 1995).

CONCLUSION

In conclusion, the results of present study showed no significant change in the physico-chemical properties of meat except for fat content which tended to increase in the meat of goats fed SeY than those fed diet without Se supplementation. The increase in fat content was associated with slight decrease in some physical characteristics such as pH, drip loss and cooking loss of meat in SeY goats, which suggest that SeY supplementation in the diet of goats slightly improves physico-chemical properties of meat.

REFERENCES

Ahmed, Z., M. Malhi, S. A. Soomro, J. A. Gandahi, A. Arijo, B. Bhutto and T. A. Qureshi. 2016. Dietary selenium yeast supplementation improved some villi morphological characteristic in duodenum and jejunum of young goats. Journal of Animal and Plant Sciences, 26 (2): 382-387.

Arain, M. A., M. Khaskheli, I. R. Rajput , S. Rao, S. Faraz , S. A. Fazlani, K. Devrajani and M. Umer. 2010. Examination of physical properties of goat meat. Pakistan Journal of Nutrition, 9 (5): 422-425.

Berg, E. A., J. Y. Wu, L. Campbell, M. Kagey and S. R. Stapleton. 1995. Insulin-like effects of vanadate and selenate on the expression of glucose-6-phosphate dehydrogenase and fatty acid synthase in diabetic rats. Biochimie, 77 (12): 919-924.

Burk, R. F. 1976. Selenium in man: Trace elements in human health and disease. A. S. Prasad. Ed. Londen: Academic Press, 2: 105-133.

DeVore, V. R., G. L. Colnago, L. S. Jensen and B. E. Greene. 1983. Thiobarbituric acid values and glutathione peroxidase activity in meat from chickens fed a selenium supplemented diet. Journal of Food Science, 48 (1): 300-301.

Esterhuyse, J. J. 2012. The effects of different selenium sources on the meat quality and bioavailability of selenium in lamb. *In:* Stellenbosch: Stellenbosch University.

Faustman, C. and R. G. Cassens. 1989. Strategies for improving fresh meat colour. Proc. 35th International Congress of Meat Sciences and Technology, 11: 446.

Gatellier, P., Y. Mercier, H. Juin and M. Renerre. 2004. Effect of finishing mode (pasture-or mixed–diet) on lipid composition, colour stability and lipid oxidation in meat from Charolais cattle. Meat Science, 69 (1): 175-186.

Grace, N. D and J. H. Watkinson. 1985. The distribution and the amounts of selenium associated with various tissues and live weight gains of grazing sheep. 490-493. *In:* Trace Elements Metabolism in man and animals (TEMA-5), Mills, C. F. Bremner, I. Chester, J. K. (Eds). Farnham Royal, Common wealth Agriculture Bureaux.

Hanson, S. W. F. and J. Olley. 1963. Application of the Bligh and Dyer method of lipid extraction to tissue homogenates. Biochemistry Journal, 89: 101-102

Hartlova, H., A. Fučikova, M. Sedmikova, E. Chmelikova, M. Krejči, A. Čtrnacta J. Škopek, L. Matěchova, and K. Vackova. 2009. Fyziologiea hygiena vyživy a alimentarni onemocněni hospodařskych zvířat. ČZU, Praha, 214, ISBN 978-80-213-1885-4.

Hernandez-Calva, L. M., J. E. Ramirez-Bribiesca, I. Guerrero-Legarreta, L. Hernandez-Cruz, L. Avendaño-Reyes, I. Dominguez-Vara and L. R. McDowell. 2013. Influence of dietary magnesium and selenium level on growth performance and carcass-meat quality in finishing diets for feedlot Pelibuey lambs. Archiv Tierzucht, 30: 1-16.

Hopkings, D. L., G. R. Ferrier, H. A. Channon and B. A. MacDonald. 1995. Assessment of lamb meat quality in Sydney and Melbourne. *In:* Proceddings New Zealand Society of Animal Production, 55: 114.

Immonen, K., M. Ruusunen and E. Puolanne. 2000. Some effects of residual glycogen concentration on the physical and sensory quality of normal pH beef. Meat Science, 55 (1): 33-38.

Kadim, I. T., O. Mahgoub, D. S. Al-Ajmi, R. S. Al-Maqbaly, S. M. Al-Mugheiry and D. Y. Bartolome. 2004. The influence of season on quality characteristics of hot-boned beef. longissimus thoracis. Meat Science, 66 (4): 831-836.

Kondaiah, N., A. S. R. Anjaneyulu, K. V. Rao, N. Sharma and H. B. Joshi. 1985. Effect of salt and phosphate on the quality of buffalo and goat meats. Meat Science, 15 (3): 183-192.

Ku, P. K., E. R. Miller, R. C. Wahlstrom, A. W. Groce, J. P. Hitchcock and D. E. Ullrey. 1973. Selenium supplementation of naturally high selenium diets for swine. Journal of Animal Science, 37 (2): 501-505.

Marounek. M., E. Skřivanová and V. Skřivanová. 2006. Selenium content and antioxidant status in tissues of veal calves fed a diet supplemented with selenium yeast. Slovak Journal of Animal Sciences, 39: 51-54.

McNeill, J. H., H. L. M. Delgatty and M. L. Battell. 1991. Insulin-like effects of sodium selenate in streptozotocin-induced diabetic rats. Diabetes, 40: 1675-1679.

Moolchand, M., J. Wang, H. Gui and Z. Shen. 2013. Ruminal butyrate infusion increased papillae size and digesta weight but did not change liquid flow rate in the rumen of goats. Journal of Animal Plant Science, 23: 1516-1521.

Morrissey, P. A., P. J. A. Sheehy, K. Galvin, J. P. Kerry and. D. J. Buckley. 1998. Lipid stability in meat and meat products. Meat Science, 49: 573-586.

Mounier. L., H. Dubroeucq, S. Andanson and I. Veissier. 2006. Variation in meat pH of beef bulls in relation to conditions of transfer to slaughter and previous history of the animals. Journal of Animal Science, 84 (6): 1567-1576.

Netto, A. S., M. A. Zanetti, G. R. Del-Claro, F. G. Vilela, M. P. Melo, L. B. Correa and S. M. P. Pugine. 2013. Copper and selenium supplementation in the diet

of Brangus steers on the nutritional characteristics of meat. Revista Brasileira de Zootecnia, 42 (1): 70-75.

Ockerman, H. W. 1985. Quality control of post-mortem muscles tissue 13th Edition. The Ohio State University, Colombus, OH.

Page, J. K., D. M. Wulf and T. R. Schwotzer. 2001. A survey of beef muscle color and pH. Journal of Animal Science, 79 (3): 678-687.

Pereira, A. S. C., M. V. D. Santos, G. Aferri, R. R. P. D. S. Corte, S. D. L. Silva, J. E. D. Freitas Júnior, P. R. Leme and F. P. Rennó. 2012. Lipid and selenium sources on fatty acid composition of intramuscular fat and muscle selenium concentration of Nellore steers. Revista Brasileira de Zootecnia, 41 (11): 2357-2363.

Pond, W. G., D. C. Church and K. R. Pond. 1995. Inorganic mineral elements. *In:* Basic Animal Nutrition and Feeding (4th Edition). John Wiley and Sons. New York. 167-224.

Sánchez-Escalante, A., D. Djenane, G. Torrescano, J. A. Beltrán and P. Roncalés. 2001. The effects of ascorbic acid, taurine, carnosine and rosemary powder on colour and lipid stability of beef patties packaged in modified atmosphere. Meat Science, 58 (4): 421-429.

Scholz, R., D. Todhunter and L. Cook. 1981. Selenium content and GSH-Px activity in tissues of young cattle fed supplemented whole milk diets. American Journal of Veterinary Research, 42 (10): 1718-1723.

Schönfeldt, H. C. and N. Gibson. 2008. Changes in the nutrient quality of meat in an obesity context. Meat Science, 80 (1): 20-27.

Sen, A. R., A. Santra and S. A. Karim. 2004. Carcass yield, composition and meat quality attributes of sheep and goat under semiarid conditions. Meat Science, 66 (4): 757-763.

Thomas, A. R., H. Gondoza, L. C. Hoffma, V. Oosthuizen and R. J. Naudé. 2004. The role of proteasome, and cathepsins B, L, H and D, in ostrich meat tenderization. Meat Science, 67 (1): 113-120.

Wardlaw, F. B., L. H. McCaskill and J. C. Acton. 1973. Effect of postmortem muscle changes on poultry meat loaf properties. Journal of Food Science, 38 (3): 421-423.

Webb, E. C., N. H. Casey and L. Simela. 2005. Goat meat quality. Small Ruminant Research, 60 (1): 153-166.

Webb, E. C. and H. A. O'Neill. 2008. The animal fat paradox. Meat Science, 80 (1): 28-36.

(Accepted: November 01, 2017)