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The Effect of Zinc Biocomplex and Vitamin E Supplementation in the Ration of the Digestibility and Nutritional Content of Kacang Goat Meat

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Abstract: This research aims to determine the effect of zinc biocomplex and vitamin E supplementation in the ration of the digestibility and nutritional content of male Kacang goat meat. A completely randomized design with 4 treatments and 6 replications was used in this research, with each replication consisting of 1 goat. Furthermore, the total number of livestock used was 24 goats with a weight range of 16.55±1.67 kg. The research treatments included DP1 = basal ration, DP2 = basal ration + zinc biocomplex 60 mg/kg BW and 1 vitamin E 400 IU, DP3 = basal ration +120 mg zinc/kg BW +1 vitamin E/400 IU and DP4 = basal ration +180 mg zinc/kg BW +1 vitamin E/400 IU. Moreover, the observed variables included feed digestibility (Dry matter digestibility, organic matter digestibility, protein), the chemical composition of meat (moisture, protein, fat, cholesterol and vitamin E, Ca, and P content), and fatty acid composition of goat meat. The results showed that zinc bio complex supplementation + vitamin E had no significant effect on feed digestibility ($p<0.05$), but could increase vitamin E levels in meat by 78.02% and PUFA levels by 27.5%. It was concluded that the use of zinc and vitamin E biocomplex can increase and improve goat meat quality.

Keywords: Supplementation, Zinc Bio Complex, Vitamin E, Cholesterol, Kacang Goats

Introduction

Feed is one of the most important factors in the livestock business, which determines the appearance of cattle production when the quality and quantity needs are fulfilled. The metabolic processes in the body also function properly when the livestock gets high quality feed. Moreover, complementary feed additives such as meat are used to promote better growth or desired production (Campo *et al*., 2006).

Nutritional content is among the most influencing factors on the quality of livestock production and reproduction compared to others. The demand for these minerals and vitamins is absolute, therefore, it needs to be present in the feed to avoid the interruption of the health and productivity of livestock (Vasta and Luciano, 2011). Moreover, poor nutrition not only reduces performance below its genetic potential but also increases the negative influence of the environment (Rostini *et al*., 2020). Therefore, serious attention to the inadequacy of nutrients quantitatively (feed consumption) and qualitatively (the imbalance of nutrients, both minerals, and vitamins) is required.

In the body of livestock, the two functions of micro minerals (zinc) include, as antioxidants (Biyatmoko *et al*., 2021), which increases bioprocesses in the rumen and post rumen and also assist in the metabolism of nutrients (Rostini *et al*., 2022). According to McDonald *et al*. (2010), the low availability of zinc in ruminants is closely related to the low content of zinc in the feed and forage provided. This mineral is important in the functional immune system and improves metabolic processes in the body. Moreover, this process is possible due to the function of zinc as a metalloenzyme (multienzyme cofactor), which is active in the metabolism of carbohydrates, proteins, fats, and nucleic acids (NRC, 2007). However, zinc has an absorption rate without the help of other components such as vitamins.

Vitamin E prevents cell membranes from the oxidation process by inhibiting the formation of lipid peroxidation (Lee *et al*., 2017). Previous research by Camo *et al*. (2011) stated that vitamin E is one of the antioxidants that play a role in maintaining optimal performance, production, and normal growth of livestock. Furthermore, Capper *et al.* (2005) stated that functions mainly as a fat-soluble vitamin that prevent lipid peroxidation of cell membranes. When used regularly as a supplement, vitamin E can promote growth and maintain zygote development. This vitamin also prevents damage to spermatozoa in males and maintains zygote development in female livestock (Qwele *et al*., 2013).

Since the existing local feed ingredients have a fairly good nutritional content with minimal mineral content, it is necessary to improve the nutrition of the feed. Moreover, improving the feed quality with zinc biocomplex and vitamin E supplementation can increase livestock productivity (Gabryszuk *et al*., 2007). Rabbits given zinc supplementation showed good productivity with higher final weight gain and lower FCR values (El-Speiy *et al*., 2022). These improvements in the natural feed are obstacles for farmers because the functional protein content, ready to use energy, and fat are very limited in leaves-based forage and agricultural waste, which harms rumen microbial growth (Rostini, 2016). The product from the digestive process has not met the goat's nutritional needs. Moreover, the nutritional content of goat milk and meat with traditional rearing systems is classified as very low, however, these substances are needed for development and growth (Macit *et al*., 2003). Therefore, this research aims to determine the effect of zinc biocomplex and vitamin E supplementation in the ration on feed digestibility, the chemical composition, amino acid content, and fatty acid composition of meat in male Kacang goats.

Materials and Methods

Research Livestock

This research used 24 male Kacang goats aged 12-15 months with an average weight of 16.55±1.67 kg, which were kept in individual metabolic cages equipped with feed and drinking containers. The goats were divided into 4 groups according to the feed treatment, with each group consisting of 6 goats as replications. Subsequently, the treatment was carried out with the approval of the code of ethics for animal husbandry research with the number P.31.03.20. From the research and service institute of Kalimantan Islamic University.

Feed and Treatment

Meanwhile, this research was conducted at the laboratory of nutrition and feed technology, Muhammad Arsyad Al-Banjari (MAB) Kalimantan Islamic University, Banjarmasin. The method used was a Completely Randomized Design (CRD), which consist of 4 treatments, 6 replications, and 24 experimental units. The treatments that were carried out included DP1 = basal ration, DP2 = basal ration + zinc biocomplex 60 mg/kg and 1 vitamin E 400 IU, DP3 = basal ration +120 mg zinc/kg +1 vitamin E/400 IU, and DP4 = basal ration +180 mg zinc/kg +1 vitamin E/400 IU. Nutritional feeds supplemented with zinc biocomplex and vitamin E are presented in Table 1. This research was designed based on the feed standards of the National Research Council (NRC, 2007).

Livestock Slaughter

The slaughtering procedure started with the fasting of the livestock for 12 h, while drinking water was still provided ad libitum. Meanwhile, the slaughtering technique, meat sample preparation, and chemical composition analysis were based on (Sari, 2016; Sainsbury *et al*., 2011; AOAC, 2005), respectively. The analysis of goat meat samples to determine productivity was carried out using the Colomer-Rocher *et al.* (1987) method. Furthermore, the quality and total amino acid content were analyzed by the AOAC (2005) using high performance liquid chromatography type ICI. The analysis of fatty acids, chemical composition, and cholesterol of meat was carried out by in situ transesterification method (Park and Goins, 1994; AOAC, 2005; Plummer, 1987) respectively.

Table 1: The nutrients of feeding supplemented by zinc-biocomplex and vitamin E

Nutrients	DP1	DP2	DP3	DP4
Dry matter (%)	92,43	92,56	93,65	93,42
Organic matter (%)	84,75	84,98	85,67	86,12
Crude protein (%)	14,12	14,05	14,14	14,27
Fat (%)	3,89	4,1	4,1	4,1
Crude fiber (%)	26,24	27,38	27,12	26,24
Total digestible nutrien	63,86	63,86	63,86	64,14
PUFA (%)	11,24	11,24	11,24	11,24
Supplement vitamin E (mg/kg/DM	0	400	400	400
Zinc biocomplex (mg/kg DM)	0	60	120	180

Information: (DP 1) = basal ration PK without supplementation of zinc-biocomplex and vitamin E
(DP 2) = basal ration + supplementation +60 mg zinc lkg as zinc-biocomplex and vitamin E
(DP 3) = basal ration + supplementation l20 mg zinc lkg as zinc-biocomplex and vitamin E
(DP 4) = basal ration + supplementation l80 mg zinc lkg as zinc-biocomplex and vitamin E

Data Analysis

The data obtained were processed by analysis of variance and differences in treatment mean were tested by Duncan's multiple range test (Steel *et al*., 1997).

Results and Discussion

Feed Consumption and Digestibility

The consumption and digestibility of Kacang goat feed that was given zinc biocomplex + vitamin E are shown in Table 2. The results showed that supplementation of biocomplex zinc and vitamin E in the rations was not significantly different (p>0.05) on nutrient consumption and digestibility. This is because the livestock obtained the required nutrients from the rations given in equal proportions, while the presence of zinc biocomplex and vitamin E supplementation gave a difference. In this research, the protein content and TDN of the feed were 14-63%, respectively, within normal limits. Previous research by Fiego *et al*. (2004); Shehata (2013) stated that the quality of feed for fattening is usually based on protein content which ranged from 12-15% and energy (TDN) of 62-70%. Furthermore, Mathius *et al*. (2002) stated that there are no differences in the consumption of dry and organic matter rations that can be influenced by the same digestive flow rate.

The digestibility of dry and organic matter rations that were not significantly different (p>0.05) was due to the insignificantly different consumption between treatments. With the supplementation of zinc biocomplex + vitamin E as stated by Van Soest (2018), the intake of digested nutrients increases in line with the increase in dry matter consumption. There is also a tendency to increase nutrient digestibility because vitamin E may increase feed digestibility due to its role as an antioxidant that prevents the oxidation of cell membrane PUFAs. This is in line with the research by Channon and Trout (2002) which stated that when livestock lacks sufficient nutrients, vitamin E supplementation increases feed digestibility because it acts as an antioxidant, which maintains the integrity of cell membranes. Meanwhile, the intestinal mucosal cells as absorption organs (Church and Pond, 1978) are expected to function optimally in absorbing nutrients when the fluidity of the cell membrane is maintained. This is because minimal changes in the fluidity of the membrane can lead to abnormal function and pathological processes of cells (Murray *et al*., 2003), therefore, normal cell function depends on cell membranes. According to McDonald *et al*. (2010), the benefits of feed ingredients are determined by their digestibility and the number of nutrients absorbed in the digestive tract.

Based on the results, there was no significant difference in crude protein consumption and body weight gain associated with dry matter consumption (p>0.05). This is in line with the research by Atti *et al*. (2004) which stated that the level of nutrient consumption that is not significantly different between treatments caused an insignificant difference in weight gain.

The Chemical Composition of Goat Meat

The effect of zinc biocomplex and vitamin E supplementation in goat rations on the chemical composition of meat is shown in Table 3. The results showed that zinc biocomplex + The results showed that zinc biocomplex + vitamin E supplementation in the rations significant effect (p<0.05) on the cholesterol content of meat. This cholesterol content can be affected by feed, however, when supplemented with zinc and vitamins, it increases acetate content as a fermented product in the rumen. This is in line with the research by Nasiu *et al*. (2013) which stated that the cholesterol content of goat meat is influenced by feed which increases the acetate content of fermented products. In ruminants, acetate is an important source of fat in the liver and adipose tissue (Hanson and Ballard, 1967). Furthermore, acetate is incorporated into fatty acids due to the high activity of acetyl-CoA synthetase. Meanwhile, Nestel *et al*. (1978) stated that acetate injection in lactating goats can increase cholesterol synthesis in the intestine.

Table 2: Average consumption and digestibility of experimental rations

	Treatment feed				
Intakes and digestibility	DP1	DP2	DP3	DP4	Significant
Dry matter consumption (g/head/day)	572,23±11.2	576,12±124	578.62±12,2	576,46±14.6	Ns
Organic consumption (g/head/day)	478,08±12.4	481,24±10.2	484,34±0012.40	483,51±08,0	Ns
Protein consumption (g/head/day)	112,57±04.7	118,34±08.3	120,27±0002.50	120,91±01.9	Ns
Dry matter digestibility (%)	70,65±02.4	72,68±03.5	73,15±0004.70	73,54±04,2	Ns
Organic ingredients digestibility (%)	71,27±02.2	71,34±05.4	73,54±0004.50	74,32±04.0	Ns
Protein digestibility (%)	70,24±03.0	72,12±02.6	74,75±0003.30	73,48±04.2	Ns
ADG (g/head/day)	78,21±05.6	79,10±04.2	80,66±0005.90	80,43±05.2	Ns

Information: (DP1) basal ration PK without supplementation of zinc-biocomplex and vitamin E
(DP2) DPl + supplementation 60 mg zinc lkg as zinc biocomplex and vitamin E
(DP3) DP1 + supplementation l20 mg zinc lkg as zinc biocomplex and vitamin E
(DP4) DP1 + supplementation l80 mg zinc lkg as zinc biocomplex and vitamin E
Ns: No significant

Moreover, the supplementation in the rations had a significant effect ($p<0.05$) on the increased vitamin E content of goat meat. Based on the results, the content in the treatment without supplementation was lower by 1.82 g/g, while those with the supplementation were increased to 3.82 g/g, which led to a percentage of 78.02%. Therefore, supplementation causes vitamin E to accumulate in muscle tissue, which increases the content of meat. According to Salvatori *et al*. (2004), the sheep that received an injection of 200 IU of vitamin E significantly increased its content in meat. Meanwhile, Schwarz *et al*. (1998) stated that the α-tocopherol concentration in bovine muscle tissue increases with a high level of vitamin E supplementation, while the α-tocopherol concentration in rabbits LD muscle significantly increases with supplementation in the rations. In this research, the results were higher than the content in goat meat as reported by at 2.55 uq/100 g. This is because vitamin E supplementation in this research was 400 mg/kg/dm in the feed.

Since Zinc biocomplex and Vitamin E supplementation can prevent cholesterol oxidation, therefore, there is a possibility to increase the cholesterol content of meat. This is in line with the research by Berges (1999) which stated that vitamin E prevents the oxidation of meat cholesterol. In this research, the cholesterol content in Kacang goat meat was still lower than those reported by Aqsha *et al*. (2011) at 71.77 mg/100 g, Correa (2011) at 63.8 mg/100 g and Williams (2007) at 66 mg/100 g. Furthermore, Werdi Pratiwi *et al*., (2006) stated that the cholesterol content of goat meat is different when the livestock differs and is given additional feed.

Fatty Acid Composition of Goat Meat

The effect of ration with zinc biocomplex and vitamin E supplementation in goat ration on the fatty acid composition of meat is shown in Table 4. The results showed that the supplementation had a significant effect ($p<0.05$) on the unsaturated fatty acid composition of meat. This was due to the low saturated fatty acid content of the feed, which is similar to each of the 11.2% treatments. However, the addition of zinc biocomplex and vitamin E gave a different saturated fat deposition in meat. This is in line with Yeom *et al*. (2005) who stated that the composition of livestock meat is influenced by feed that contained saturated fat. Similarly, Banskalieva *et al*. (2000) also stated that PUFA intake and ruminant feed affect the fatty acid composition of meat.

Table 3: Nutritional, cholesterol, and vitamin content of goat meat supplemented with zinc biocomplex and vitamin E in feed

Parameter	DP1	DP2	DP3	DP4	Level of signification
(Moisture (%)) ns	75,67±0,42	75,89±2,70	76,12±1,23	76,18±1,42	ns
Protein (%) ns	20,45±2,4	20,87±1,46	21,35±1,64	21,60±1,76	ns
Fat (%) ns	2,82±1,24	2,78±1,12	1,88±0,54	1,98±1,45	ns
ash (%) ns	1,04±0,12	1,34±0,24	1,49±0,22	1,52±0,32	
Meat cholesterol (mg/100 g)	35,82^{a}±0,73	43,33^{b}±2,08	49,31^{c}±4,19	49,31^{c}±4,19	*
Ca (ml/100%)	12.84±0,12	13,05±0,32	13,37±0,47	13,24±0,68	ns
P (mg/100%)	2,72±0,54	2,84±0,55	3,04±0,61	3,15±0,16	ns
Vitamin E (uq/100 g)	2,02^{a}±0,14	2,63^{ab}±0,21	3,24^{b}±0,55	3,82^{b}±0,12	*
Zinc (mg/100 g)	4,05^{a}±0,25	4,84^{a}±0,47	5,54^{b}±0,82	5,67^{b}±0,42	*

Information: (DP1) basal ration PK without supplementation of zinc biocomplex and vitamin E
(DP2) DPl + supplementation 60 mg zinc lkg as zinc biocomplex and vitamin E
(DP3) DP1 + supplementation l20 mg zinc lkg as zinc biocomplex and vitamin E
(DP4) DP1 + supplementation l80 mg zinc lkg as zinc biocomplex and vitamin E
Ns: No significant

Table 4: Fatty acid composition of goat meat supplemented with zinc biocomplex and vitamin E in the feed

Fatty acids (mg/100 g)	DP1	DP2	DP3	DP4	Level of signification
Lauric acid (C12:0)	11,42±2,4	12,1±1.2	13,42±3,2	12,24±3,1	ns
Myristic acid (C14:0)	47,54±1,1	47,82±2,4	48,64±2,1	47,89±2,8	ns
Palmitic acid (C16:0)	452,73^{a}±4,6	459,84^{b}±2,2	461,52^{b}±4,3	461,21^{b}±2,6	*
Heptadecanoic acid (C17:0)	63,24±3,4	64,58±4,7	65,76±6,5	66,72±4,5	ns
Stearic acid (18:0)	334,54^{a}±3,5	346,74^{b}±6,2	351,63^{c}±8,3	352,52^{c}±6,4	*
Oleic acid (C18::1)	654,23^{a}±11,6	684,12^{b}±10,2	687,76^{b}±6,7	687,98^{b}±8,2	*
Linoleic acid (C18:2)	1476,75^{a}±8,6	1587,64^{b}±7,2	1696,86^{c}±4,8	1686,54^{c}±6,2	*
Linolenic acid (C18:3)	176,32^{a}±2,3	178,83^{a}±3,4	180,65^{b}±2,6	181,54^{b}±4,6	*
PUFA	6,88^{a}±0,54	6,92^{a}±1,23	8,32^{b}±1,56	8,47^{b}±2,2	*

Moreover, the criteria for healthy meat are not only seen from cholesterol content but are determined by the fatty acid types and content that contribute to lowering cholesterol content when consumed. This is in line with the research by Banskalieva *et al*. (2000); Assan (2012) which stated that not all saturated fatty acids increase blood cholesterol content. Stearic acid (C18:0) and unsaturated fatty acids (oleic) also play a role in reducing meat cholesterol content (hypocholesterolemic), while palmitic acid (C16:0) functions during the increase of the cholesterol content (hypercholesterolemic). The ratio of hypocholesterolemic to hypercholesterolemic fatty acids is expressed as (C18:0 + C18:1)/C16:0 and is used to describe the health benefits of hypocholesterolemic compounds. Therefore, a higher ratio indicated that the hypocholesterolemic ability is higher than hypercholesterolemic. In this research, goat meat treated with zinc biocomplex and vitamin E supplementation (DP4) showed a hypocholesterolemic effect that was twice larger. This showed that the meat produced was classified as good because it contained the required fatty acids in sufficient quantities.

The effect of zinc biocomplex and vitamin E supplementation showed that the PUFA content was significantly ($p<0.05$), with an increase of 23.11% compared to without supplementation. These results were lower than those of (Nasiu *et al*., 2013) who stated that the addition of vitamin E in the rations increased the saturated fatty acid content of goat meat by 27.80%.

Kacang goats supplemented with vitamin E to a level of 400 mg in the feed produced meat with a Polyunsaturated Fatty Acid (PUFA) content of more than 27.5% (Karami *et al*., 2011). The PUFA content of goat meat can be increased by supplementing with zinc biocomplex + vitamin E, which acts as an antioxidant to prevent PUFA oxidation This is carried out by breaking various free radical chain reactions of polyunsaturated fatty acids that have passed through peroxidation. Moreover, Murray *et al*. (2003); Bjørneboe *et al*. (1990) stated that zinc and vitamin E can inhibit the peroxidation of polyunsaturated fatty acids, while Channon and Trout (2002) stated that the addition of minerals and vitamins increases PUFA.

Conclusion

The results showed that the supplementation of zinc biocomplex and vitamin E did not affect the consumption and digestibility of feed. However, it was able to improve the nutritional quality of goat meat, especially vitamin E and PUFA content.

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Author's Contributions

Tintin Rostini: Compiled the experimental designed.

M. Irwan Zakir: Coordinated the feeding trial research.

Danang Biyatmoko: Collected data and performed the statistical analysis.

Ethics

This article is original and has never been published anywhere. The author has also confirmed to all authors involved in this research to read and agree to the contents of this article and there are no ethical issues involved.

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