IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 9, Issue 7 Ver. I (July 2016), PP 00-00
www.iosrjournals.org

Nutritional evaluation of Kenya alpine dairy goat (*Capra aegagrus hircus*) milk: Effect of geographical location vs. feeding practices

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Abstract: *This study used a randomized complete block design to assess milk nutritional and chemical composition, with each region treated as a block. Ten pedigree dairy goats were identified in each region, where randomization was achieved by collecting milk samples from each farm in triplicates over a period of three months. Dairy goat milk obtained from Mukurweini region had significantly ($p<0.05$) higher amount of ash (0.96g/100ml), fat (4.01 g/100ml) and protein (4.58 g/100ml) as compared to the other two regions of Kieni East and Kieni West. The mineral composition differed clearly among the three regions with Mukurweini giving significant($p<0.05$) high amounts of calcium 152.61 mg/100ml, magnesium 19.90 mg/100ml, iron 0.84 mg/100ml, zinc 0.57 mg/100ml, sodium 51.04 mg/100ml and potassium 196.65 mg/100ml. Dairy goat milk from Mukurweini region also had significant ($p<0.05$) high levels of methionine 2.84 g/100g protein, phenylalanine 5.56 g/100g protein, threonine 4.79 g/100g protein, histidine3.61 g/100g protein and leucine10.73 g/100g protein. The study established that the Kenya alpine dairy goat milk quality is affected by the geographical location of the dairy goat rearing.*

Keywords: *Kenya alpine dairy goat, milk, geographical location, grade, feeding practices.*

I. Introduction

In Kenya, one way of mitigating the problem of malnutrition is to encourage milk production enterprises among small-scale farmers, where business incubation enterprises provide a long term response to food insecurity through securing food reserves and critically addressing the biting poverty that is pervasive in the rural areas. The production of goat's milk in Kenya has been increasing steadily over the past few years, with little scientific and technical information available on the quality of milk produced by the different goat breeds. Several authors have examined the nutritive value of goat milk taking into consideration the feeding effect [1,2,3] but little is known about its composition in relation to geographical location in specified areas. In areas where the land holding/family are too small (0.5 to 1.5 acres) to support large ruminant livestock, dairy goats have become appropriate targets for research and development attention and it is on this background that the research was undertaken.

The nutrient compositions of goat milk can be greatly influenced by several factors such as season, stages of lactation, breed, diet, individual animal and environmental management conditions [4]. Chemical composition: protein, lactose and fat contents, greatly determine the milk quality. Dietary characteristics of dairy goats influence milk yield and composition, with previous studies showing a positive correlation between both the amount and the concentration of metabolizable energy, milk protein content and yield [5] altered by the synchrony of the degradation rate of carbohydrate and protein in the diet. The study assessed the nutritional and chemical of milk from Kenya Alpine dairy goats reared in Mukurweini, Kieni East and Kieni West regions of Nyeri County.

II. Materials and methods

The experiment was carried out at Mukurweini, Kieni East and Kieni West constituencies of Nyeri County, Kenya. Mukurweini is a high potential area with a mean annual rainfall and temperature of 1100 mm and 20°C, respectively. It is a vibrant agricultural sector with the main agricultural enterprises being tea, coffee and dairy. Land in this sub county has been fragmented into very small units due to high population pressure. On the other hand Kieni East and Kieni West are the only semiarid areas of Nyeri County, which make up Kieni constituency which is one of the most expansive constituencies in the country, covering the entire span from the slopes of the Aberdares to the slopes of Mt. Kenya with a mean annual rainfall and temperature of 700 mm and 30°C, respectively. Agro-pastoralism is the dominant livelihood system in this region.

2.1. Experimental design

The study comprised farmers who are registered with the Dairy Goat Association of Kenya (DGAK) and have undergone adequate training in dairy goat keeping, practicing good husbandry and producing enough milk in Mukurweini which is a high potential area and Kieni East and West as semi arid areas of Nyeri County. All the goats were fed on natural pastures that included indigenous fodder shrubs like weeds, shrubs; banana leaves, potato peels, nappier grass, maize stalks, sweet potato vines, green leafy twigs and Calliandra. The farmers mainly used the available material found on the farm.

Ten pedigree Kenya alpine dairy goats in their second lactation in ten farms per region were identified, based on the best animal husbandry practices, like cleanliness, feeding and dairy upkeep of the goats. Using a randomized complete block design, each region was treated as a blocks, where milk samples were collected twice a month in each farm, over a period of three months. Milk collection was done once a week in each farm, where 500ml of milk was drawn per milking session. Samples were collected from the farms, and frozen at -20°C.

2.2. Chemical analysis

The milk total solids, ash, protein (N x 6.38), fat and solids-not-fat were determined using standard procedures of AOAC 2005 [6]. The determination of lactose present in the milk was first carried by the method of Dileesh, [7]. Minerals were determined by AOAC 2005 method [6], using Atomic Absorption Flame Emission Spectrophotometer (Shimadzu Corp., Tokyo Japan, and Model AA 6200). Phosphorus was determined by with the vanadomolybdate colorimetric method [8].

2.3. Fatty acids analysis

The composition of fatty acids was determined by esterification [9] followed by gas chromatography, using a glass column, prepacked and preconditioned by Shimadzu; Shinchrom E-71 5% Shimalite (80-100 Aw), 3.1 m in length by 3.2 mm internal diameter and flame ionization detector. Isothermal column temperature of 200°C was used and injector/detector temperature of 230°C.Flow rate was 2.8 ml/minute, injection Volume 1µl. Gases used were nitrogen carrier gas at 2.63 kg/cm^{2,} Hydrogen at 0.68 kg/cm^2 and air at 0.35 0.68 kg/cm^2.Shimadzu integrator software was used to calculate the peak areas. Fatty acids were calculated on basis of µg/ml.

2.4. Vitamins analysis of goat milk

Ascorbic acid, thiamin and niacin were determined by a reversed-phase HPLC method [10], using HPLC (Shimadzu, Japan) PE series 400 liquid chromatography fitted with a photo-diode detector, a C_{18} column ODS 250 mm x 4.0 mm stainless steel at 35°C oven temperature. Mobile phase was 0.1 mol/litre di-potassium phosphates (pH 7): methanol 90:10, flow rate 0.7ml/min and injection volume 20 µl. Shimadzu software was used to calculate the peak areas.

Riboflavin was determined separately by AOAC 2005 [6] method, using a HPLC (Shimadzu, Japan) PE series 400 liquid chromatography fitted with a UV detection detector, a C_{18} column ODS 150 mm x 4.6 mm stainless steel at 35°C oven temperature, at 270 nm flow rate 1ml/min and injection volume 10 µl. Shimadzu software was used to calculate the peak areas.

Vitamin E (α-Tocopherol) was analyzed using the method of Ubaldi *et al.* [11], with modification, where the analysis was performed in a HPLC Model LC-10AS, Shimadzu Corp., Kyoto, Japan fitted with UV detector at 205-340 nm wavelength filter, stainless steel column NOVA-PAK C_{18}, 3.9 mmX15 cm column at 35°C oven temperature. Mobile phase: methanol: water 95:5 (both HPLC grade) at a flow rate of 1.5 ml/minute and injection volume of 20 µl. Shimadzu software was used to calculate the peak areas. Peak heights of tocopherol in the sample extracts were measured and compared with those of the standards.

2.5. Amino acids profile of goat milk

Precolumn derivatization of amino acids with o-phthalaldehyde (OPA) followed by reversed-phase HPLC separation with fluorometric detection was used according to method described by Bartolomeo and Maisano [12], with modification from Albert *et al.* [13]. This technique does not detect amino acids that exist as secondary amines (e.g., proline). Chromatography condition was in accordance with the Agilant method [14], where the hydrolyzed samples and amino acid standards solutions were automatically derivatized with OPA solution at a ratio of 1:1. OPA solution was prepared by mixing 0.5 mg/ml of OPA to borate diluent (pH 10.4), 0.1% (v/v) 2-mercaptoethanol and 0.1% (v/v) of Brij 35. After derivatization, an amount equivalent to 10 µl of each sample was injected on an ODS column 5µm, 250 x 4.6 mm at 40°C, with detection at 350 nm excitation wavelength and 450 nm emission wavelength. Mobile phase A was 40mM di-potassium phosphate, adjusted to pH 7.8 with NaOH, while mobile phase B was acetonitrile/methanol/water (45/45/10 v/v/v). The separation was obtained at a flow rate of 1 ml/minute with a gradient program that allowed for 1.9 min at 0% followed by a

16.3 min step that raised eluent B to 53%. The washing at 100% B and equilibration at 0% B was performed within 30 minutes. Analysis was performed using a HPLC PE series 400 liquid chromatography fitted with a binary pump delivery system, column thermostat and a fluorescence detector. Amino acids were detected based on the retention time established for the individual amino acid under defined experimental conditions. Calculation was based on the intensity established for a given amino acid of known concentration.

2.6. Statistical analysis

The data was subjected to analysis of variance (ANOVA) in a randomized complete block design using the general linear model procedure of (SPSS) software Version 18 of 2010 [15]. The treatment means were separated using list significant difference.

III. Results And Discussion

3.1. Chemical composition of goat milk

The chemical composition of milk from pedigree dairy goats in different geographical locations is shown in Table 1. According to this study variations were noted in milk chemical composition for dairy goats in semi-arid and high potential areas under the study. The non-protein nitrogen and lactose were not significantly different ($p>0.05$) in the three regions. Lactose is the main determinant of milk volume. A close relationship between lactose synthesis and the amount of water drawn into milk makes lactose a stable milk component [16]. As in cows milk, lactose constitutes the main carbohydrate in goat milk. Goat milk does contain less lactose than cow milk (on average, 4.1% vs. 4.7%), but cannot be regarded as a dietary solution to people suffering from lactose intolerance [17]. Milk composition and quality are important attributes that determine the nutritive value and consumer acceptability. However, when different geographic regions with varying fodder composition are considered, the various nutritional components vary considerably. Mukurweini region had significant ($p<0.05$) higher amount of ash, fat and protein as compared to the other two regions of the semi arid area.

Table 1: Chemical composition of pedigree goat milk

g/100ml	Kieni East (n=10)	Kieni West (n=10)	Mukurweini (n=10)
Moisture	^{a}84.87±0.7	^{b}87.46±0.1	^{a}85.03±0.1
Ash	^{a}0.20±0.00	^{a}0.25±0.00	^{b}0.96±0.01
Fat	^{a}2.49±0.10	^{b}3.43±0.03	^{c}4.01±0.01
Protein (N x 6.38)	^{a}3.42±0.2	^{a}3.43±0.02	^{b}4.58±0.5
Non-protein Nitrogen	^{a}0.001±0.00	^{a}0.002±0.00	^{a}0.003±0.00
Lactose	^{a}4.64 ±0.10	^{a}4.02±0.07	^{a}4.76 ±0.24
Total solids	^{b}15.13 ±1.00	^{a}12.54±0.54	^{b}14.51 ±0.94
Solids-non-fat	^{b}12.64±1.07	^{a}9.11±0.49	^{a}10.50 ±0.37

The data are mean value ± standard deviation (SD) of ten replicates.
[a]Values within a row marked with different superscript are significantly different ($P<0.05$).

Goat milk protein content in Kieni West 3.43 g/100ml, and Kieni East 3.42 g/100ml were within the normal range for goat milk [18, 19]) and similar to values reported in other goat breeds [20, 21]. However, Mukurweini region had significantly ($p<0.05$) higher amount of ash 0.96 g/100ml, fat 4.01 g/100ml and protein 4.58 g/100ml as compared to the other two regions of the semi-arid area. Ash content was low in Kieni West, 0.25g/100ml and Kieni East 0.20g/100ml, and significantly higher in Mukurweini region, 0.96g/100ml, which could be attributed to type of fodder available for the dairy goats in that region. Nutritional value of milk is closely related with its composition, which is highly affected by factors such as breed, feed, stage of lactation and season [22]. Total protein content was comparable to values reported for goats' milk of different breeds worldwide [18, 23, 24, 25, 26] while, fat in Mukurweini was comparable to goat milk from other breeds [25]. The fat content in Kieni East was significantly lower than Kieni West and Mukurweini. The goat milk from Mukurweini was rich in terms of ash, fat and protein, which can be attributed to the nutritious types of fodder available in that area. Machen, [27], reported that majority of naturally occurring mineral deficiencies in herbivores are associated with specific regions and are directly related to soil characteristics.

Raynal-Ljutovac *et al.* [28] reported total solids up to 14.8% (w/w), fat up to 5.63% (w/w) and crude protein contents up to 4.09% (w/w) which were far above the levels that were found in Kieni East and Kieni West, but close to those of Mukurweini region. However the values for proximate composition obtained in this study are close to the average concentrations given by Souci *et al.* [29], which is very often used by food

chemists as a source of reference values concerning the composition of foods, (13.4% total solids, 3.92% fat and 3.69% crude protein).

The mineral composition differed clearly among the three regions as shown in Table 2, with Mukurweini region giving significantly ($p<0.05$) higher amounts of calcium, magnesium, iron, zinc, sodium, potassium. Copper content was not affected by the treatments, while equal amounts of phosphorous was obtained in both Kieni East and West. Milk is an important source of mineral substances, especially calcium, phosphorus, sodium, potassium, chloride, iodine, magnesium, and small amounts of iron. The main mineral compounds of milk are calcium and phosphorus, which are substantial for bone growth and the proper development of newborns [30]. The mineral composition differed clearly among the three region, with Mukurweini region giving significantly ($p<0.05$) higher amounts of calcium 152.61mg/100ml, magnesium 19.90 mg/100ml, iron 0.84 mg/100ml, zinc 0.57 mg/100ml, sodium 51.04 mg/100ml and potassium 196.65 mg/100ml. Copper content was not affected by the treatments, while equal amounts of phosphorous 1.12 mg/100mlwas obtained in both Kieni East and West. Goat milk is characterized by the lowest concentration of iron, zinc, and copper [31]. Despite the low iron concentration in goat milk, iron is more bioavailable in goat milk than it is in cow milk.

Table 2: Mineral composition of pedigree goat milk

Minerals (mg/100ml)	**Kieni East (n=10)**	**Kieni West (n=10)**	**Mukurweini (n=10)**
Calcium	41.69±1.10[a]	50.33±1.10[b]	152.61±3.80[c]
Magnesium	3.92±0.30 [a]	4.31±0.50[a]	19.90±1.50[b]
Iron	0.12±0.01 [a]	0.15±0.01 [a]	0.84±0.04 [b]
Zinc	0.15±0.01 [a]	0.18±0.01 [a]	0.57±0.01 [b]
Copper	0.03±0.00 [a]	0.03±0.00 [a]	0.06±0.01[a]
Sodium	13.95±0.40 [a]	15.99±0.40 [b]	51.04±0.40[c]
Potassium	50.32±1.06 [b]	46.09±1.23 [a]	196.65±4.76[c]
Phosphorous	1.12±0.07[b]	1.12±0.01[b]	0.86 ±0.02[a]

The data are mean value ± standard deviation (SD) of ten replicates.
[a]Values within a row marked with different superscript are significantly different ($P<0.05$).

3.2. Fatty acids composition of goat milk

The fatty acid profile of goat's milk and its changes resulting from the geographical area are shown in Table 3.The goat milk from Mukurweini, was significantly ($p<0.05$) higher in saturated fatty acids; palmitic 28.23% and stearic 21.44% than milk produced in the semi arid areas, and significantly ($p<0.05$) low amounts of lauric acid 3.66%. The percentage of total fat in goat and cow milk is quite similar, and the fatty acid composition depends to a large extent on the diet composition in both species [17]. Processing goat milk is affected by the size of fat globules and fatty acid composition. The smaller size fat globules in goat milk in comparison to those in cow milk, results in the softer texture of goat milk products and it makes manufacture of butter from goat milk difficult. The fatty acid composition of goat milk contains a higher proportion of medium-chain fatty acids, i.e., caproic (C6:0), caprylic (C8:0) and capric (C10:0), which are partly responsible for the characteristic odour of goat milk, as much of the odour originate from the buck [17].

Table 3: Fatty acid composition (%total fat) of pedigree goat milk

Fatty acid μg/ml	**Kieni East (n=10)**	**Kieni West(n=10)**	**Mukurweini (n=10)**
Butyric (4:0)	1.62±0.07[a]	1.67±0.06[a]	0.34±0.21[a]
Caproic (6:0)	0.30±0.07[a]	0.46±0.35[a]	0.28±0.08[a]
Caprylic (8:0)	1.56±0.43[a]	1.72±0.41[a]	1.22±0.15[a]
Capric (10:0)	8.30±1.01[a]	9.61±1.16[a]	6.41±1.09[a]
Lauric (12:0)	4.46±1.03[a]	4.74±0.71[a]	3.52±0.59[a]
Myristic (14:0)	11.25±0.22[a]	10.81±0.92[a]	10.67±0.51[a]
Pentadecanoic (15:0)	1.374±0.13[a]	1.10±0.00[a]	1.52±0.17[a]
Palmitic (16:0)	25.13±0.42[b]	23.67±2.71[a]	28.23±1.52[c]
Pamitoleic (16:1)	1.22±0.36[a]	1.57±0.36[a]	1.40±0.52[a]
Heptadecanoic (17:0)	0.48±0.02[a]	0.54±0.11[a]	0.53±0.11[a]
Stearic (18:0)	13.55±0.92[a]	17.04±0.46[b]	21.44±1.20[c]
Oleic :18:1) *cis*	16.51±1.28[a]	16.13±0.78[a]	15.85±0.72[a]
Elaidic (18:1) *trans*	2.27±0.86[a]	2.17±0.14[a]	2.45±0.34[a]
Linoleic (18:2) *cis*	1.74±0.33[a]	2.03±0.43[a]	1.43±0.25[a]
Linolelaidic (18:2) *trans*	1.49±0.67[a]	1.20±0.53[a]	1.01±0.59[a]
Linolenic (18:3)	0.54±0.15[a]	0.55±0.22[a]	0.85±0.25[a]

The data are mean value ± standard deviation (SD) often replicates.
[a]Values within a row marked with different superscript are significantly different ($P<0.05$).

In the high potential areas of Mukurweini the milk was significantly higher in saturated fatty acids; palmitic 28.23 µg/ml and stearic 21.44 µg/ml, than milk produced in the semi-arid areas. Diet has the greatest influence on milk fatty acids [32], and age, timing of cutting and species composition of forage should be considered in diet formulation [33]. In order to cover nutrient needs of high production, the energy and protein density of the daily feed intake must increase, because of the limitation of the rumen in volume capacity. Roughages like grass, hay or silages are mostly low in energy and protein density because of high fiber and/or water contents [34].

3.3. Vitamins composition of goat milk

The vitamin compositions of goat's milk from the three geographical regions are shown in Fig 1, that indicated that dairy goat milk obtained from the three regions did not differ significantly ($p>0.05$) in thiamine, content, while significant ($p<0.05$) low levels of niacin and riboflavin, were noted in Kieni west. Mukurweini gave significantly ($p<0.05$) higher amounts of riboflavin 1.04µg ml^{-1} and α-tocopherol 1.35 µg ml^{-1} as compared to the other two regions.

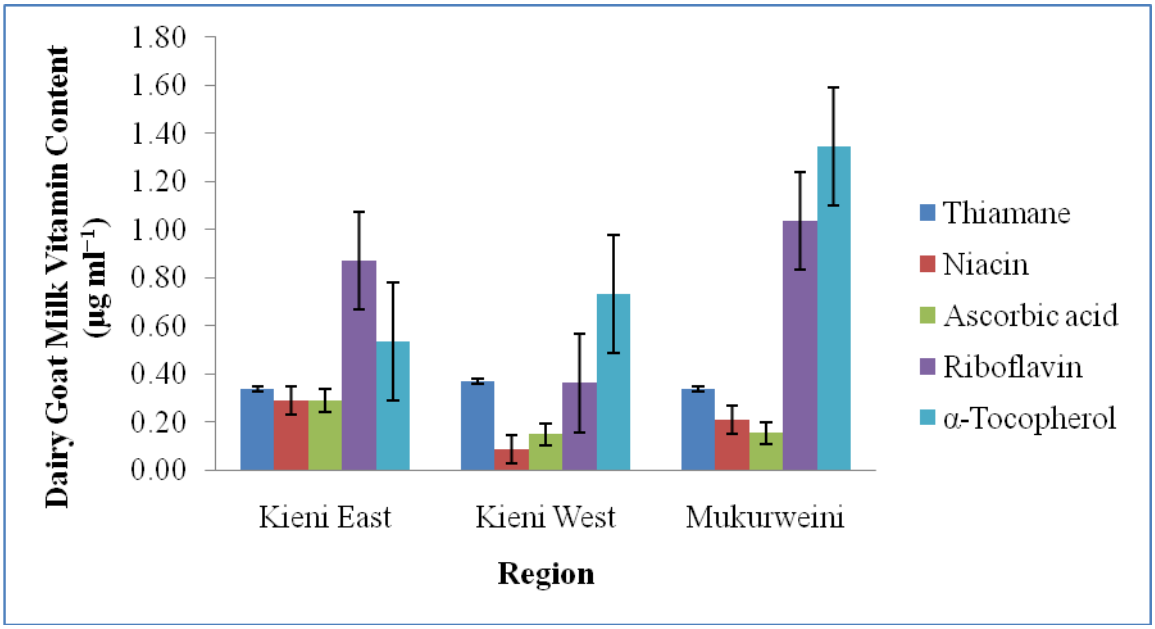

Figure 1: Vitamin composition of pedigree goat milk

Milk is a valuable source of vitamins, both water-soluble and fat-soluble ones. Water soluble vitamins and tocopherols indicated that dairy goat milk obtained from the three regions did not differ significantly ($p<0.05$) in thiamine, content, while significant ($p<0.05$) low levels of niacin 0.09µg ml^{-1} and ascorbic acid 0.15µg ml^{-1}, were noted in Kieni west. Mukurweini gave significantly ($p<0.05$) higher amounts of riboflavin 1.04µg ml^{-1} and α-tocopherol 1.35 µg ml^{-1} as compared to the other two regions, a factor attributed to the fodder type available in that region, in agreement with Silanikove *et al.*, [17]. Goats need feeding of fat soluble vitamins (A, D, E, and K) in the diet due to its inability to make these vitamins. Rumen flora can make vitamin B in enough quantities needed for goat metabolism as well as vitamin C. The fresh green fodder at Mukurweini region could create a good environment in the goat's rumen for synthesis of water soluble vitamins. Goat milk is a good source of vitamin A, niacin, thiamin, riboflavin, and pantothenic acid. However, it contains 5 times less vitamin B12 and folic acid than cow milk does [31].The α-tocopherol is chemically and biologically the most active among the vitamin E molecules, an important component of the cellular defense system and protects the cell membrane and cell content from oxidation [35]. Vitamin E is only biosynthesized by plants and distributed in milk principally as α-tocopherol.

3.4. Amino acids profile of goat milk

The amino acids profile of pedigree dairy goat milk is shown in Table 4. Since tryptophan is destroyed by acid hydrolysis its values are not reported. Because glutamine is converted to glutamate and asparagine to aspartate during the hydrolysis, the values reported as glutamate include both glutamate and glutamine and those for aspartate include both aspartate and asparagine.

The determination of the amount of sulfur containing amino acids under the generally used protein hydrolysis conditions (6M hydrochloric acid) leads to a part of these amino acids undergoing oxidative

deterioration [13]. To prevent the losses of this thiol group of these amino acids, performic acid oxidation of cysteine and methionine was done to form cysteic acid and methionine-sulphon. Therefore the loss of these molecules during hydrolysis was negligible related to that of the initial amino acids. Total amino acid concentration is the sum of all particular amino acids analyzed. Significant ($p<0.05$) higher amount of amino acids were obtained in both Kieni East and Mukurweini regions, with lysine 7.62% and 7.92% respectively , isoleucine 5.62% and 5.99% respectively and valine 7.62% and 7.98% respectively. Mukurweini region also had significant ($p<0.05$) high amount of methionine 2.84%, phenylalanine 5.56%, threonine 4.79%, histidine3.61% and leucine 10.73%.

The high-quality protein in milk plays a crucial role in nutrition which could provide amino acid for the human body, especially in developing countries where diets are largely cereal based. The amino acids profile results in Table 4 indicate that some of the essential amino were significantly ($p<0.05$) higher in both Kieni East and Mukurweini regions. These were acids lysine 7.62% and 7.92% respectively, isoleucine 5.62% and 5.99% respectively and valine 7.62% and 7.98% respectively. These essential amino acids make the milk nutritious in terms of protein content. Mukurweini region also had significant high amount of methionine 2.84%, phenylalanine 5.56%, threonine 4.79%, histidine 3.61% and leucine 10.73%. The significant amounts of essential amino acids in milk protein were due to the high nitrogenous fodder given to the dairy goats in this region. The other two regions being semi-arid have dry shrubs that are low in nitrogenous matter. Due to the great variability in the protein composition of goat milk, careful control of the amino acid pattern of protein used is important, when the milk is used in the manufacture of other products. The non-essential amino acids were not significantly ($p<0.05$) different in the three regions under study. Glutamate which includes both glutamic acid and glutamine, was the highest amino acid identified for the three regions, Kieni West 21.21g/100g protein, Kieni East 21.26 g/100g protein and Mukurweini 22.35 g/100g protein. According to Guo *et al.,* [36]; and Sheng *et al.,* [37], bovine milk is a good supply of glutamic acid that could be used in the biological protein metabolism in the body.

Amino acids pattern in milk protein changes only within the frame of experimental error. The amino acids analysis was done to detect typical amino acids that are present in milk. Hydrolysis was carefully done to avoid destroying sensitive amino acids and hydrolyzing reagents removed by evaporation then derivatized with a fluorometric reagent before detection. Of the essential amino acids present, the most abundant in both the goat milk were lysine, leucine and valine which were in agreement with findings of Sabahelkheir *et al.,* [38]. In accordance with findings of Hejtmánková *et al.,* [39], goat milk amino acid profile is similar to that of ewe and also cow milk. Amino acids are vital nutrients for growth and maintenance of health in humans. Further research and more data are needed for determination and validation of the real pattern of sulfur amino acids in goat milk. The content of nitrogen components in goat milk varies according to breed, genetics, season, stage of lactation and feed [40].

Table 4: Amino acids profile of pedigree goat milk

Amino acid concentration(g/100g protein)				
Essential amino acid		**Kieni East (n=10)**	**Kieni West (n=10)**	**Mukurweini (n=10)**
	Lysine	7.62±0.33[b]	6.69±0.45[a]	7.92±0.34[b]
	Methionine	2.24±0.31[a]	2.13±054[a]	2.84±0.46[b]
	Phenylalanine	4.98±0.31[a]	5.01±0.25[a]	5.56±0.57[b]
	Threonine	4.15±0.35[a]	3.98±0.43[a]	4.79±0.22[b]
	Histidine	2.90±0.06[a]	2.70±0.24[a]	3.61±0.13[b]
	Leucine	10.24±0.08[a]	9.81±0.15[a]	10.73±0.19[b]
	Isoleucine	5.62±0.15[b]	5.31±0.26[a]	5.99±0.24[b]
	Valine	7.62±0.45[b]	6.05±0.25[a]	7.98±0.33[b]
	TEAA[1](%)	45.37	41.68	49.42
Non- essential amino acid				
	Aspartate[2]	8.68±0.40[a]	8.54±0.15[a]	8.10±0.40[a]
	Serine	2.90±0.51[a]	2.52±0.64[a]	2.54±0.51[a]
	Alanine	3.54±0.06[a]	3.26±0.22[a]	3.76±0.06[a]
	Cysteine	2.87±0.08[a]	2.81±0.17[a]	3.01±0.08[a]
	Tyrosine	3.68±0.15[a]	3.62±0.40[a]	3.86±0.15[a]
	Arginine	3.31±0.12[a]	3.32±0.42[a]	3.46±0.12[a]
	Glutamate[3]	21.26±0.42[a]	21.21±0.12[a]	22.35±0.42[a]

[a]Mean values having different letters within a row are significantly difference at $P<0.05$, of ten replicates.
[1]TEAA = total essential amino acids
[2]aspartate includes both aspartate and asparagine
[3]glutamate includes both glutamate and glutamine

IV. Conclusions

There were differences in milk quality among Kenya Alpine dairy goat pedigree grade from the three geographical regions. Dairy goats in Mukurweini region produced milk of higher quality in terms of ash, fat and protein as well as minerals and essential amino acids. The findings of this study forms the basis for dairy goat milk improvement, where documented results on effect of geographical location on milk composition can facilitate value addition to assist small scale farmers address the constraints that hinder initiation of processing facilities. Kenya alpine dairy goats are reared by farmer groups registered with Dairy Goat Association of Kenya (DGAK), who can establish milk value addition projects using locally adaptable technology to enhance their nutrition as well as income generation.

Acknowledgements

The authors acknowledge gratefully the financial support from DAAD Kenya for the In-country scholarship offered for this study, and the technical support from the Institute of Food Bioresources Technology at Dedan Kimathi University of Technology, and Dairy Goat Association of Kenya (DGAK).

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