http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

OPEN ACCESS Pakistan Journal of Biological Sciences

ISSN 1028-8880
DOI: 10.3923/pjbs.2020.113.118

Research Article
Impact of Extended Lactation on Fatty Acid Profile and Milk Composition of Dual Purpose Tropical Goat

Yustina Yuni Suranindyah, Rochijan, Budi Prasetyo Widyobroto and Sulvia Dwi Astuti

Department of Animal Production, Faculty of Animal Science, Universitas Gadjah Mada, Jalan Fauna No. 3, Bulaksumur, 55281 Yogyakarta, Indonesia

Abstract

Background and Objective: Extended lactation has been implemented to increase milk yield in limited case. There is need further investigation in term of milk composition, fatty acid profile and milk flavour as recommendation for further implementation. **Materials and Methods:** The study lasted from July-September, 2017, used thirty lactating Etawah Crossbred goats in small farms of Sleman, Yogyakarta. Samples were collected from normal period and extended lactation which lasted for 2-3 months and longer than 10 months, respectively. The data on milk yield, composition, physical quality, fatty acids profile, sensory properties and nutrient consumption were measured on samples of 14 consecutive days. Assessments were done in Faculty of Animal Science and Integrated Research Laboratory, Universitas Gadjah Mada. Statistical analysis used ANOVA and Kruskal Wallis test and were processed with SPSS programme version 16. **Results:** Extended lactation did not affect milk yield and nutrient consumption of goat but caused higher content of milk fat, protein, total solid, acidity, caprylic, capric and total short-chain fatty acids in compared with normal lactation ($p<0.05$). The average values were 5.33, 4.40, 15.85, 0.30, 1.99, 9.10 and 12.13% vs. 3.75, 3.64, 13.55, 0.26, 1.69, 7.09 and 9.76% of total fatty acids in milk, respectively. Fatty acid profile did not associate with milk flavour. **Conclusion:** Composition, acidity and short chain fatty acids content in milk of extended lactation were higher than in normal period but did not change milk flavour.

Key words: Fatty acid, milk yield, milk composition, dual purpose goat, extended lactation

Citation: Yustina Yuni Suranindyah, Rochijan, Budi Prasetyo Widyobroto and Sulvia Dwi Astuti, 2020. Impact of extended lactation on fatty acid profile and milk composition of dual purpose tropical goat. Pak. J. Biol. Sci., 23: 113-118.

Corresponding Author: Yustina Yuni Suranindyah, Department of Animal Production, Faculty of Animal Science, Universitas Gadjah Mada, Jalan Fauna No. 3, Bulaksumur, 55281 Yogyakarta, Indonesia

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The demand of milk by people in Indonesia was majority met from cow's milk. However, lately was observed the potency of consuming milk from other farm animals, such as goat. Milk from goat has been popular due to its composition, which was believed to cure certain kind of disease. However, the preference to consume goat milk often being handicapped by specific character which known as 'goaty' flavour. According to cited literature, palatability and sensory properties of milk and products of dairy goat were influenced by the concentration of short-chain fatty acid and free fatty acids[1-3]. Short and medium-chain fatty acids in goat milk were particularly composed by C6:0, C8:0 and C10:0 during lactation[4,5] and were reported to have a 'goaty' flavour[6]. The existence of short and medium fatty acid in goat milk reached 15.29-18.00% of total fatty acid in milk[4,7].

The profit of dairy goat farm could be achieved by maximizing milk yield. Lactation length is one factor which known to influence yield and composition in dairy cow[8], whereas in dairy goat those effects depended on breed and management[9]. High producing goat breed was reported could maintain lactation up to 2 years with production level upwards of 3-4 L/day[10]. Conversely, dual purpose goat breed has short lactation as shown by Etawah Crossbred goats. Under smallholder management Etawah Crossbred goat could produce milk about 0.98 L/day[11] with kidding interval of 240-320 days[12] and lactation period around 5-7 months[13].

Extended lactation has been implemented in Etawah Crossbred goat in order to maximize milk production by several farmers. The does were managed to reach long lactating exceeded the normal duration by prevented mating, therefore did not undergo dry period. In other breed of goat, the effect of extended lactation did not decrease milk yield[10]. Similarly, the length and stage of lactation were shown as factors which affected milk yield and composition[14-16]. Thus the aim of the present study was to evaluate the effect of implementation extended lactation on Etawah Crossbred goats from the aspect of milk yield, chemical composition, fatty acid profile and milk sensory.

MATERIALS AND METHODS

Study area: The study was held during 3 months, from July-September, 2017 used thirty lactating Etawah Crossbred goats from small farms of Pakem, Sleman, Yogyakarta. The does characterized by undergoing 2nd parities and weighed around 51-53 kg. Samples were separated into groups of normal lactation and extended lactation in balanced number. The lactation period of does in normal and extended lactation lasted for 2-3 months and longer than 10 months, respectively. The extended lactation was done by delayed mating, so that caused the doe to continue lactation. All does were raised individually in the lifted pen completed with feed through and water container. Daily feed composed of forages (*Calliandra calothyrsus* and *Pennisetum purpureum*) and concentrate (a mixture of tofu waste and wheat pollard). Milking was done routinely, every morning (07.00-08.00 am) and evening (15.00-17.00 pm). Laboratory analysis were done in the Faculty of Animal Science and Integrated Research Laboratory, Universitas Gadjah Mada, Yogyakarta.

Milk sampling and analysis: The data consisted of daily yield, chemical composition, physical quality, fatty acids profile, sensory properties of milk and nutrient consumption were measured from samples which were taken during 14 consecutive days. Milk yield was recorded from daily milking. Milk sample were taken from individual goat, 3 times during the period of data collection. Samples were transferred in cool condition to laboratory for determination of milk composition (fat, protein and total solids), physical quality (alcohol test, pH and acidity, consistency), fatty acids profile and milk flavour (smell and taste) of milk. Determination of milk fat and crude protein followed Babcock and Kjeldahl methods[17]. Total solid was calculated using a formula, based on the value of specific gravity and milk fat. Alcohol test was assessed with 55% of alcohol followed[18]. Milk acidity was determined by titration method and expressed in percentage of titrable lactic acid. Fatty acids in milk were measured by gas chromatography using Methyl ester 37 New 3032017 Kal, gcm method, with column HP-88, length: 100 m. The value was presented as a percentage of total fatty acid. Milk sensory was examined by 10 panels. The parameters of milk sensory were assessed using scores. The score for milk colours ranged from 1 (white) to 2 (yellowish). Score of flavour consisted of 1 (smell or taste of milk), 2 (goaty), 3 (strong goaty) and texture 1 (liquid), 2 (less viscous), 3 (viscous). Nutrient consumption was measured by weighing feed given subtracted by remaining feed after 24 h multiplied with nutrient content. Determination of feed composition (dry matter, crude protein, extract ether and ash content) was done by proximate analysis. Laboratory assessments were done in the Faculty of Animal Science and Integrated Research Laboratory, Universitas Gadjah Mada.

Statistical analysis: The data on milk yield, chemical composition, physical quality, fatty acid content and score of sensory properties were expressed as Mean±Standard deviation. To compare means between normal and extended lactations the data were statistically analyzed by using a one-way analysis of variance (ANOVA) and Kruskal Wallis test. All data were processed by using SPSS programme version 16. Probability at $p<0.05$ was considered statistically significant.

RESULTS

Milk yield and composition of goats during lactation: The implementation of extended lactation did not show significant effect on goat milk production. On the other hand total solid, fat and protein content of milk from extended lactation were significantly higher ($p<0.05$) than those in normal lactation (Table 1). The physical quality was observed no difference in the colour, consistency, alcohol test and pH value of milk but the acidity level was higher ($p<0.05$) in milk of extended lactation than in normal period.

Fatty acid profile in goats milk: Fatty acid profile of milk was markedly affected ($p<0.05$) by extended lactation with exception on butyric and caproic acids (C4:0 and C6:0). Butyric and caproic acids content (Table 2) ranged around 3% of total fatty acid in milk. The fatty acid profile indicated that caprylic, capric, total short-chain fatty acids, lauric, myristic and total medium-chain fatty acid in milk of extended lactation were higher than those in normal lactation ($p<0.05$). The result did not show association between the concentration of short-chain fatty acid, caprylic, capric acids and milk flavour. The score of sensory property (Table 1) indicated that both of lactation periods produced milk with low intensity of 'goaty' smell and taste.

Body weight and body condition score of goats: The average body condition score (BCS) were presented in Table 3. Body weight did not differ between lactation periods. On the other hand, body condition score of extended lactation goat was higher than in normal period ($p<0.05$), so that indicated an association between BCS and the length of lactation period.

Nutrient consumption of goats: There was no effect of extended lactation on nutrient consumption of goat (Table 4). The result demonstrated the capability of goat to maintain appetite during long period lactation. On average dry matter consumption were 4.1 and 4.6% of body weight in goat of normal and extended lactation, respectively.

Table 1: Milk yield and milk composition of goat

	Mean±SD	
Parameters	Normal lactation	Extended lactation
Milk yield (L/day)	0.83±0.32[a]	0.75±0.28[a]
Chemical composition		
Milk gravity	1.031±0.002[a]	1.033±0.002[b]
Total solid (%)	13.55±0.94[a]	15.85±1.12[b]
Fat (%)	3.75±0.74[a]	5.33±0.88[b]
Protein (%)	3.64±0.85[a]	4.40±0.70[b]
Physical quality		
Colour score	1.627±0.464[a]	1.629±0.362[a]
Consistency score	1.168±0.388[a]	1.154±0.359[a]
Alcohol test	(-) 15 (15)[a]	(-) 15 (15)[a]
pH	6.61±0.13[a]	6.53±0.25[a]
Acidity (Titrable lactic acid (%))	0.026±0.003[a]	0.030±0.003[b]
Score organoleptic test		
Smell	1.79±0.24[a]	1.88±0.22[a]
Taste	1.99±0.32[a]	1.86±0.26[a]

[a,b]Different superscripts within rows indicate significant differences ($p<0.05$), SD: Standard deviation, L: Liter, pH: Power of hydrogen

Table 2: Fatty acid profile in milk (percentage of total fatty acid)

	Mean±SD	
Fatty acid profile	Normal lactation	Extended lactation
Butyric (C4:0)	3.62±1.92[a]	3.39±1.32[a]
Caproic (C6:0)	0.97±0.10[a]	1.04±0.14[a]
Caprylic (C8:0)	1.69±0.26[a]	1.99±0.29[b]
Capric (C10:0)	7.09±1.72[a]	9.10±1.85[b]
Total (C6:0, C8:0, C10:0)	9.76±1.98[a]	12.13±2.16[b]
Lauric (C12:0)	2.74±1.44[a]	4.08±1.48[b]
Myristic (C14:0)	6.45±2.86[a]	9.45±1.96[b]
Total short and medium chain fatty acids (C4:0-C14:0)	34.05±6.67[a]	42.83±7.00[b]
Total long chain fatty acids (C>14)	29.14±3.31[a]	30.88±2.31[b]

[a,b]Different superscripts within rows indicate significant differences ($p<0.05$), SD: Standard deviation

Table 3: Body weight and body condition score of goats in the different lactation phase

	Mean±SD	
Variables	Normal lactation	Extended lactation
Stage of lactation (month)	2.90±0.40[a]	12.20±1.20[b]
Body weight (kg)	51.71±8.41[a]	52.92±8.55[a]
Body condition score	2.72±0.60[a]	3.13±0.51[b]

[a,b]Different superscripts within rows indicate significant differences ($p<0.05$), SD: Standard deviation

Table 4: Nutrient consumption of goat (g kg^{-1} body weight)

	Mean±SD	
Chemical composition of feed	Mid lactation	Late lactation
Dry matter	41.96±8.52[a]	46.23±7.38[a]
Crude protein	7.14±1.24[a]	7.45±0.95[a]
Crude fiber	8.65±2.03[a]	9.96±1.69[a]
Total digestible nutrient	25.02±5.44[a]	28.14±4.58[a]

[a]Superscripts within rows indicate non-significant differences ($p>0.05$), SD: Standard deviation

DISCUSSION

The capability of Etawah Crossbred goat to continue production in long period was evidenced by the data on milk yield which was no difference between normal extended lactation, with average of 0.83±0.32 and 0.75±0.28 L/day, respectively. This results in line with previous reports regarding to the effect of extended lactation, which showed no significant decreased of milk yield, plateaued lactation curve and fewer kids production[10,19,20]. Therefore, based on the aspect of milk yield, extended lactation in this study could be suggested as an effort to maximize production of dual purpose goat. According to Khan *et al.*[21] the process of decreasing in milk yield during late lactation was characterized by a loss of cells and decreasing power of galactopoietic hormones due to effect of pregnancy. The does that undergo extended lactation in this study did not experience pregnancy, consequently there were more number of survive epithelial cells, so that milk synthesis and secretion could be maintained until subsequent months.

The existence of long period lactation in this study seemed to be supported by high body condition score (BCS). The BCS value as around 3.0-3.5 was in the range of BCS of healthy goat, between 2.5-4.0 as recommended by Ockert[22]. Body condition is a very important factor in determining potential milk production, especially in the period of late gestation and kidding. Goat could produce milk in long duration if those received adequate nutrient in good BCS along with lactation[23]. To maintain long lactation period the does in this study used reserved energy, after lactation lasted for 10 months. High BCS was important to be considered in implementation of extended milking. The study showed that duration of milking period was longer than both dual purpose and pure dairy goats' lactation, ranged from 215-235 days[24]. Long period of lactation in this study in line with that occurred in well-fed non-pregnant goats, which were capable to continue lactation up to 22 months and even for 2-4 years[20].

The study showed that total solid, fat and protein in milk of extended lactation were significantly higher than in normal lactation. This result agreed with the reports of Zailan and Yaakub[25] on Jamnapari Crossed goat, showed that during mid-lactation milk fat and total solids were in the lowest content, averaged of 3.37 and 12.3%, respectively. Similarly, previous studies reported the increase of fat, protein and total solid due to lactation stage[26,27] and the length of lactation as a factor of variation in milk yield and composition[9]. The average content of fat, protein and total solids of milk during end of lactation were 3.8-3.9, 3.3-3.7 and 12.5-17.7%, respectively[3,24]. Milk fat and total solid content increased towards the end of lactation period and coincided with a decrease in milk yield[24].

The chemical composition indicated that milk secreted during extended lactation period was more nutritious and acceptable for consumption. However, the acidity which valued of 0.30% was higher than previously observed ranged from 0.23-0.26% in Etawah Crossbred goat milk[28]. The acid condition in milk of this study apparently associated with total solid content which was observed to be higher in extended lactation milk than in normal lactation. Lactose as a component of total solid presumably contributed to cause high milk acidity.

In this study, the fatty acid profile of milk from extended lactation indicated higher concentration of caprylic, capric, sum of short-chain fatty acid and medium-chain fatty acid, myristic and lauric acid in compared with those in normal lactation. The results emphasized that fatty acid profile during extended lactation was more affected by goat feed than lactation period. The role of feed was shown by supplying acetic acid for synthesis de novo in mammary gland.

The effect of extended lactation on the concentration of short-chain fatty acids in this study was opposite with Strzalkowska e*t al.*[3], who observed maximum content at the beginning of lactation and dropped in the last stage of lactation. The lactation stage effect is mainly linked to lipid store mobilization in early lactation, which lasted a few weeks each year[29]. The study results also differed from other reports which showed similarity in the content of total medium-chain fatty acid (C6:0-C12:0) throughout the stages of lactation of Jamnapari, German Fawn crossbred and Damascus goat[15,25]. In this study, short-chain fatty acids content in normal lactation was low as a result of physiological limitation of goats to consume adequate dry matter to meet energy requirement in early lactation[30].

Based on the result on nutrient consumption, extended lactation goat showed high dry matter intake (Table 4), so that high nutrient component was available to meet the requirement of milk production. The effect of low dry matter intake decreased the dietary supply of acetate, which consequently reduced the production of de novo short-chain fatty acids by mammary tissue and increased the mobilization of adipose tissue fatty acids during early stage of lactation. The negative energy balance during early lactation was explained by Belyea and Adams[31], cause the mobilization of adipose tissue fatty acids consisting of long-chain fatty acids which inhibited de novo synthesis of short-chain fatty acids by mammary tissue. According to Parodi[32], in late lactation more of the fatty acids in milk are formed in the

mammary gland so that the concentration of the short chain fatty acids such as butyric (C4:0) and caproic (C6:0) are higher than they are in early lactation. Caproic, caprylic and capric acids were particularly composed short and medium-chain fatty acids in goat milk and was reported to have 'goaty' flavour[4-6]. In this study, caproic acid content was not affected by extended lactation, whereas caprylic and capric acids were significantly increased. Therefore, the sum of short-chain fatty acids was dominated by caprylic and capric acids.

Butyric acid in milk did not differ by the periods of lactation. The average content of 3.63 and 3.11% of fatty acid in milk was similar with normal level of butyric acid in goat milk as reported by Sadooghy-Saraby[33] was around 3%. Butyric acid characterized by having low molecular weight, inherent volatility, low odour threshold in aqueous solutions[34] could be absorbed rapidly in the upper gastrointestinal tract and smell rancid[35]. There was no significant effect of extended lactation on total long-chain fatty acid (>C14:0) in milk of Etawah Crossbred goat. Zailan and Yaakub[25] explained that high content of long-chain fatty acid in late lactation due to both higher secretion of long-chain fatty acids in the blood and a lower de novo synthesis of fatty acids. De novo synthesis in the mammary tissue produces the majority of the saturated fatty acids from C4:0-C14:0 and half of the palmitic acid (16:0).

The implementation of extended lactation did not influence milk flavour. Based on the sensory assessment score, milk in all lactation periods of this study has low intensity of 'goaty' smell and taste. Despite of caprylic and capric acids content in milk of extended lactation were higher than in normal lactation, the effect did not alter milk flavour. This result emphasized that caproic acids content was more dominant to form 'goaty' flavour of milk than caprylic and capric acids. The average content of short-chain fatty acid was lower than previously reported as around 15.29-18.00% of total fatty acid in milk[4,7]. Palatability and sensory properties of milk and dairy goat products were decided by the concentration of short-chain fatty acid (C6:0, C8:0 and C10:0) and free fatty acids[1-3]. Short and medium-chain fatty acids in goat milk were synthesized de novo in the mammary gland[4,5] and reported to have a 'goaty' flavour[6].

The study results showed that lactation period of Etawah Crossbred goat that was classified as dual purpose[36], could be extended to be longer than normal period. This effort was successfully implemented by farmers and could reach maximum production with better composition, but no significant change in milk flavour. However, this technique required certain condition, such good BCS and sufficiency of nutrition consumption by the lactating does. In consideration with kid production, the extended lactation suggested to be implemented in multiparous goat which already low in reproductive performance. This study has weakness in term of lactation period investigation, since the data were only represented by 14 days collection. Skipped dry period in extended lactation goat probably damaged milk secretoric cell in mammary gland. Therefore, it necessary to continue study on mammary gland structure as a result of extended lactation, especially in dual purpose goat.

CONCLUSION

Implementation of extended lactation on Etawah Crossbred goat could maintain the level of milk yield similar with that in normal lactation. In compared with normal lactation, milk of extended lactation was characterized by higher in total solids, fat and protein, acidity level, short and medium-chain fatty acid, especially caprylic and capric acids. Both of lactation periods produced milk containing low intensity of 'goaty' flavour but fatty acid profile and milk flavour was no association.

SIGNIFICANCE STATEMENT

Extended lactation in dual purpose goat changed milk chemical content, i.e., milk total solid, fat and protein were higher than in normal lactation. There was also effect on fatty acid profile markedly shown by high content of short-chain fatty acids, especially caprylic and capric but did not increase 'goaty' flavour in milk.

REFERENCES

1. Eknæs, M., K. Kolstad, H. Volden and K. Hove, 2006. Changes in body reserves and milk quality throughout lactation in dairy goats. Small Rumin. Res., 63: 1-11.
2. Eknæs, M., O. Havrevoll, H. Volden and K. Hove, 2009. Fat content, fatty acid profile and off-flavours in goats milk-Effects of feed concentrates with different fat sources during the grazing season. Anim. Feed Sci. Technol., 152: 112-122.
3. Strzalkowska, N., A. Jozwik, E. Bagnicka, J. Krzyzewski, K. Horbanczuk, B. Pyzel and J.O. Horbanczuk, 2009. Chemical composition, physical traits and fatty acid profile of goat milk as related to the stage of lactation. Anim. Sci. Pap. Rep., 27: 311-320.
4. Chilliard, Y., J. Rouel and C. Leroux, 2006. Goat's alpha-s1 casein genotype influences its milk fatty acid composition and delta-9 desaturation ratios. Anim. Feed Sci. Technol., 131: 474-487.
5. Sampelayo, M.R.S., Y. Chilliard, P.H. Schmidely and J. Boza, 2007. Influence of type of diet on the fat constituents of goat and sheep milk. Small Rumin. Res., 68: 42-63.

6. Brennand, C.P., J.K. Ha and R.C. Lindsay, 1989. Aroma properties and thresholds of some branched-chain and other minor volatile fatty acids occurring in milkfat and meat lipids. J. Sensory Stud., 4: 105-120.
7. Markiewicz-Keszycka, M., G. Czyzak-Runowska, P. Lipinska and J. Wojtowski, 2013. Fatty acid profile of milk-a review. Bull. Vet. Inst. Pulawy, 57: 135-139.
8. Osterman, S., 2003. Extended calving interval and increased milking frequency in dairy cows: Effects on productivity and welfare. Ph.D. Thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden.
9. Assan, N., 2014. Effect of milking frequency and lactation length on yield and milk composition in goats. Agric. Adv., 3: 292-299.
10. Salama, A.A.K., G. Caja, X. Such, R. Casals and E. Albanell, 2005. Effect of pregnancy and extended lactation on milk production in dairy goats milked once daily. J. Dairy Sci., 88: 3894-3904.
11. Cyrrila, L., B.P. Purwanto, A. Atabany, D.A. Astuti and A. Sukmawati, 2015. Improving milk quality for dairy goat farm development. Media Peternakan, 38: 204-211.
12. Sodiq, A., 2004. Doe productivity of Kacang and Peranakan Etawah goats and factors affecting them in Indonesia. J. Agric. Rural Dev. Trop. Subtrop., 78: 11-120.
13. Widyobroto, B.P., S.D. Astuti, S.W. Adiarto, Y. Suranindyah, T.W. Murti, B. Rustamadji and R.C. Riandika, 2016. Respon koefisien toleransi panas kambing perah saanen terhadap indeks suhu dan kelembaban lingkungan pada manajemen pemeliharaan di BBPTU-HPT baturraden (PTPe-67-O). Prosiding Simposium Nasional Penelitian dan Pengembangan Peternakan Tropik, November 3, 2016, Fakultas Peternakan Universitas Gadjah Mada, Yogyakarta, pp: 215.
14. Kuchtik, J., K. Sustova, T. Urban and D. Zapletal, 2008. Effect of the stage of lactation on milk composition, its properties and the quality of rennet curdling in East Friesian ewes. Czech J. Anim. Sci., 53: 55-63.
15. Gueler, Z., M. Keskin, T. Masatcioglu, S. Gul and O. Bicer, 2007. Effects of breed and lactation period on some characteristics and free fatty acid composition of raw milk from damascus goats and German fawn × hair goat B_1 crossbreds. Turk. J. Vet. Anim. Sci., 31: 347-354.
16. Oravcova, M., M. Margetin, D. Peskovicova, J. Dano, M. Milerski, L. Hetenyi and P. Polak, 2007. Factors affecting ewe's milk fat and protein content and relationships between milk yield and milk components. Czech J. Anim. Sci., 52: 189-198.
17. AOAC., 2005. Official Methods of Analysis. 18th Edn., Association of Official Analytical Chemists, Washington, DC., USA.
18. Guo, M.R., S. Wang, Z. Li, J. Qu, L. Jin and P.S. Kindsted, 1998. Ethanol stability of goat's milk. Int. Dairy J., 8: 57-60.
19. Douhard, F., N.C. Friggens, J. Tessier, O. Martin, M. Tichit and D. Sauvant, 2013. Characterization of a changing relationship between milk production and liveweight for dairy goats undergoing extended lactation. J. Dairy Sci., 96: 5698-5711.
20. Zobel, G., D.M. Weary, K.E. Leslie and M.A.G. von Keyserlingk, 2015. Cessation of lactation: Effects on animal welfare. J. Dairy Sci., 98: 8263-8277.
21. Khan, S., M.S. Qureshi, I. Ahmed and S.M. Shah, 2011. Milk composition and yield changes with advancing pregnancy in dairy buffaloes (*Bubalus bubalis*). Turk. J. Vet. Anim. Sci., 35: 375-380.
22. Ockert, K., 2015. Body condition scoring in goats. Michigan State University Extension, East Lansing, MI., USA., November 3, 2015. https://www.canr.msu.edu/news/body_condition_scoring_in_goats
23. Koyuncu, M. and S.O. Altincekic, 2013. Importance of body condition score in dairy goats. Macedonian J. Anim. Sci., 3: 167-173.
24. Ketto, I.A., I. Massawe and G.C. Kifaro, 2014. Effects of supplementation, birth type, age and stage of lactation on milk yield and composition of Norwegian x Small East African goats in Morogoro, Tanzania. Livest. Res. Rural Dev., Vol. 26, No. 12.
25. Zailan, M.Z. and H. Yaakub, 2018. Milk composition and fatty acids profile at different stages of lactation in Jamnapari crossbred goats. Malays. J. Anim. Sci., 21: 109-122.
26. Idamokoro, E.M., V. Muchenje and P.J. Masika, 2017. Yield and milk composition at different stages of lactation from a small herd of Nguni, Boer and non-descript goats raised in an extensive production system. Sustainability, Vol. 9. 10.3390/su9061000.
27. Auldist, M.J., C. Grainger, A.V. Houlihan, J.J. Mayes and R.P.W. Williams, 2010. Composition, coagulation properties and cheesemaking potential of milk from cows undergoing extended lactations in a pasture-based dairying system. J. Dairy Sci., 93: 1401-1411.
28. Nurliyani, Y. Suranindyah and P. Pretiwi, 2015. Quality and emulsion stability of milk from ettawah crossed bred goat during frozen storage. Procedia Food Sci., 3: 142-149.
29. Chilliard, Y. and A. Ferlay, 2004. Dietary lipids and forages interactions on cow and goat milk fatty acid composition and sensory properties. Reprod. Nutr. Dev., 44: 467-492.
30. Palmquist, D.L., A.D. Beaulieu and D.M. Barbano, 1993. Feed and animal factors influencing milk fat composition. J. Dairy Sci., 76: 1753-1771.

31. Belyea, R.L. and M.W. Adams, 1990. Energy and nitrogen utilization of high versus low producing dairy cows. J. Dairy Sci., 73: 1023-1030.
32. Parodi, P.W., 2004. Milk fat in human nutrition. Aust. J. Dairy Technol., 59: 3-59.
33. Sadooghy-Saraby, S., 2011. Assessment of the entrapment of free fatty acids in goat milk by β-cyclodextrin and reduction of goaty flavour. Master Thesis, School of Applied Sciences, AUT University, Auckland, New Zealand.
34. Belitz, H.D., W. Grosch and P. Schieberle, 2009. Food Chemistry. 4th Edn., Springer, Heidelberg, Germany, ISBN: 978-3-540-69934-7, Pagse: 1070.
35. Pituch, A., J. Walkowiak and A. Banaszkiewicz, 2013. Butyric acid in functional constipation. Prz. Gastroenterol., 8: 295-298.
36. Sutama, I.K., 2009. Productive and reproductive performances of female Etawah Crossbred goats in Indonesia. Wartazoa, 19: 1-6.