Effect of Parity Order and Lactation Stage on Physico-Chemical Properties of Anglo Nubian X Etawah Grade Goat Milk

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ABSTRACT

Many crossbreeding program in dairy goat has been done to increase milk production. Knowing physico-chemical properties of goat milk is important to understand its quality. A preliminary study was conducted to investigate effect of parity and lactation stage on physico-chemical properties of goat milk in F1 Anglo Nubian x Etawah Grade goats. The study was done in the Dairy Goat Unit, Indonesian Research Institute for Animal Production. About 540 milk samples collected for 5 months of lactation from 27 does consisted of 3 parities were used in this study. Parameters of physico-chemical properties of milk observed were fat, protein, lactose, total solid, pH, density, freezing point, temperature and salt. All parameters observed were significantly affected by parity order ($P<0.05$), except temperature, density and pH. Stage of lactation affected significantly fat, total solid and density ($P<0.05$). First parity and early lactation showed lowest fat and total solid ($P<0.05$). Across parities and lactation stage, physico-chemical properties of Anglo Nubian x Etawah grade goat milk met the requirement of National Standard of goat milk.

Keywords: parity, lactation, physic-chemical, Anglo-Nubian, Ettawah

INTRODUCTION

Goat has been exploited for its milk, since ancient times. Goat's milk has a similarity to human milk and also has several medicinal values containing various nutrients either as major components or as macro and micro components. The production of goat milk is major importance in many places, especially where climatic conditions are not favorable for dairy cattle (Idowu and Adewumi, 2017). Nowadays the contribution of goat milk ranked the third after cow milk and buffalo milk according to FAO (2015).Therefore awareness about advantage of consumption of goats milk should be popularized so that production and utilization of goat's milk could be enhanced (Park and Haenlein, 2017).

Many crossbreeding program in dairy goat has been done to increase goat productivity in producing milk (Garcia et al., 2014). There are many dairy goat breed with excellent milk production such as Anglo Nubian that has been used for crossbreeding to local goats in many countries (Garcia-Peniche et al., 2012). The Anglo Nubian (AN) has the highest adaptability in the tropic condition with the highest fat content of milk and milk production ranged 3-4 kg/day (Lobo et al., 2017). Indonesian Research Institute for Animal Production has done a crossbreeding program using Anglo Nubian bucks mated to Etawah Grade (PE) does to improve goat milk production since 2012.

Milk composition and quality are important attributes that determine the nutritive value and consumer acceptability (Wanjekeche et al., 2016). The composition of goat's milk widely differs according to many various factors, such as breeds, parity order, stage of lactation, litter size, season and feeding or rations components (Getaneh et al., 2016; Idowu

and Adewumi, 2017; Lobo et al., 2017). Knowing physico-chemical of goat milk is important to understand its quality.

A preliminary study was carried out to investigate the effect of parity order and stage of lactation on physic-chemical properties of goat milk in ANxPE does. This study is a useful information for establishing a new composite breed of dairy goat.

MATERIALS AND METHODS

This study was carried out at the Dairy Goat Unit of Indonesian Institute for Animal Production, in Bogor, located at 250-350 m above sea level. The study had been done for 5 months. About 27 does of F1 ANxPE were used in this study. The does were divided into 3 parity order (1, 2 and 3). The three stages of lactation, early, middle and late were less than 2 month of lactation, between 2 and 3 month of lactation and between 4 and 5 month of lactation, respectively.

All animals were reared in the same management system. They were fed 0,8 kg/head/day of concentrate 16-17% Crude Protein and 65-70% TDN. Forages containing King grass were given about 4-5 kg/head and 0.5-0.6 kg/head/day of legumes (*Caliandra, Leucaena, Gliricidae*). Clean water were available *ad libitum*.

Does were milked twice a day (morning and afternoon) by hands. Morning-milked sample were evaluated using lacto-scan. All samples of 540 were analyzed to obtain physic-chemical properties of goat milk, which were fat, protein, lactose, solid non fat (SNF), total solid (SNF + fat), density, water, temperature and salt. The procedure was described previously by Praharani et al (2015). The milk sample was recorded monthly from each doe in plastic bottles.

The data generated were subjected to analysis of variance using the General Linear Model (GLM) of SAS (2003). Parity order and lactation stage were included in the model as a source of variation. Effects were considered significant at 0.05 level using P-DIFF test.

RESULTS AND DISCUSSION

The physic-chemical composition of goat milk are presented in Table 1. The average of fat content was 5.84% higher than those in the National Standard 01-3141 (SNI, 1998) score of 3%. According to Thai Agricultural Standard (TAS, 2008) stated that the fat content of goat's milk above 4% is classified into the Premium. Therefore goat milk in this study was categorized to Premium. Some studies found fat content in Etawah grade ranged between 4-4.9% (Zuriati et al 2011; Praharani et al, 2015). However, other studies showed higher fat content ranged 6.27-7.60% in Etawah crossbred. Many reviews summarized from different goat breeds and countries has reported that fat content ranged 3.06-7.8% (Abbas et al., 2014; Wanjekeche et al., 2016; Park and Haenlein, 2017).

The mean of total solid was 13,92% which was classified as Premium according to TAS (2008) because it was higher than 13%. However the SNI (1998) does not have a require minimum for total solid. Some studies reported that total solid of Etawah grade and crossbred were between 12.71 and 14.97% (Zuriati et al., 2011; Sumarmono et al., 2012; Praharani et al., 2015). While Abbas et al (2014) and Kumar et al (2012) showed in review that total solid ranged 11.76-21.55%, with the highest of 21.55% in Pygmy goat.

Table 1 showed the average of density was 1.0279 similar to density of goat milk that was determined by SNI (1998) and TAS (2008), which was 1.028. The range of density in PE and their crossbred between 1.028 and 1.0303 found by some studies (Zuriati et al. 2011;

Sumarmono et al., 2012; Praharani et al., 2015). A review (Wanjekeche et al., 2016) stated the range of density was 1.0305-1.0359.

Table 1. Description of data of physic-chemical properties of goat milk

	N	Minimum	Maximum	Mean	Standard deviation
Fat,%	540	3.23	7.19	5.84	1.06
Total solid,%	540	9.97	15.76	13.92	1.52
Lactose,%	540	3.25	4.50	3.72	0.25
Protein,%	540	3.43	4.56	3.91	0.24
Density	540	1.0248	1.0294	1.0279	0.001
Salt,%	540	0.53	0.75	0.60	0.04
PH	540	6.57	7.04	6.72	0.12
Temperature, ^oC	540	30.30	35.60	33.34	1,34
Freezing point, ^oC	540	-0.55	-0.39	-0.47	0.03

Protein content in present study was 3.91%. The SNI (1998) determined protein content must be above 2.8%. The goat milk in this study was above 3.7% and classified as Premium according to TAS (2008). Many reports showed that the range of protein content was 2.8-4.29% in Etawah grade and their crossbreds (Zuriati et al., 2011; Sumarmono et al., 2012; Praharani et al., 2015). However, protein content summarized from Abbas et al (2014) and Wanjekeche et al (2016) were 2.9-4.71% and the Pygmy goat had the highest.

According to Table 1, the mean of lactose content was 3.72%. The SNI (1998) and TAS (2008) did not show a minimum requirement for lactose. However, this finding was in the range of some studies in Etawah grade and their crossbreds, between 3.55 and 3.93% (Sumarmono et al., 2012; Prihatminingsih et al., 2015; Praharani et al., 2015). Some studies from different countries and breeds reported that lactose content was higher from this present study, ranged from 4.06-6.03% (Abbas et al., 2014; Kučević et al., 2016; Lobo et al., 2017).

The mean of pH in this study was 6.72, similar to pH in SNI (1998) ranged 6.5-6.7. TAS (2008) stated that pH of goat milk must be 6.5-6.8. The ranged of pH in fresh goat milk according to some studies between 6.0-6.99, with the lowest and the highest found in the field (Sukarini, 2012; Setiawan et al., 2013). Reviewed by Park and Haenlein (2017) found pH between 6.5-6.8.

In Table 1, the mean of freezing point was -0.47^oC. Studies (Summarmono et al., 2012; Setiawan et al., 2013) in Etawah grade found freezing point was -0.50^oC - (-0.44^oC). However, Park and Haenlein (2017) showed freezing point ranged -0.54^oC and -0.57^oC.

The mean of temperature of goat milk in this study was 33.34^oC and mean of salt content was 0.60%. The different of physic-chemical properties of goat milk from ANxPE in this study compared to literature was due to different breed, management practices, and season and year of lactation (Getaneh et al., 2016; Idowu and Adewumi, 2017; Lobo et al., 2017).

Least squares means for physic-chemical constituents of ANxPE milk by parity order and lactation stage are presented in Table 2 and 3. Parity order affected fat, total solid, lactose, protein and freezing point of ANxPE milk ($P<0.01$), but not salt, pH, density and temperature ($P>0.05$). The significant increase of milk fat with increasing parity found in this study was in line with the findings of some studies (Abbas et al., 2014; Klir et al., 2015). Reviewed by Getaneh et al (2016) stated that parity order or age of does affected milk constituents. Differences due to parity, number of lactation or age of animal can be significant in gross milk composition, but this is also confounded with milk yield levels.

The mean of fat and total solid percentage differ significantly ($P<0.05$) between parity order, with an increased trend. In first parity the lowest fat and total solid have been showed,

with the highest in third parity. The milk fat and total solid increased following parity order. Total solid consisted of solid non fat and fat, therefore, increase in fat content resulted in higher total solid. However, lactose and protein milk had a similar trend, with increasing from first parity to second parity, then decreasing from second to third parity. While other properties such as temperature, salt, freezing point showed no trend on parity order.

Table 2. Least square means, standard error and p-value in different parity

		Parity		
Component	P-value	First	Second	Third
Fat,%	<0.0001	4.79^{a}±0.27	6.12^{b}±0.26	6.63^{b}±0.18
Total solid,%	<0.0001	12.39^{b}±0.46	14.60^{a}±0.32	14.77^{a}±0.28
Lactose.%	0.0030	3.73^{a}±0.03	3.92^{a}±0.09	3.52^{b}±0.06
Protein,%	0.0025	3.93^{a}±0.04	4.10^{a}±0.08	3.72^{b}±0.06
Density	0.4356	1.026±0.004	1.027±0.005	1.027±0.005
Salt,%	0.0770	0.62^{a}±0.02	0.61^{ab}±0.01	0.57^{b}±0.01
PH	0.4213	6.83±0.03	6.74±0.04	6.76±0.05
Temperature, ^{o}C	0.7106	33.59±0.34	33.31±0.53	33.13±0.48
Freezing point, ^{o}C	0.0015	-0.48^{a}±0.005	-0.49^{a}±0.01	-0.44^{b}±0.009

^{abc}within the same rows, values with different letters are significantly different at P<0.05)

Table 3. Least square means, standard error and p-value in different lactation stage

		Stage of lactation		
Component	P-value	Early	Mid	Late
Fat,%	<0.0001	5.13^{a}±0.23	6.03^{b}±0.19	6.37^{c}±0.17
Total solid,%	0.0002	12.98^{a}±0.29	14.22^{b}±0.36	14.57^{b}±0.35
Lactose,%	0.4797	3.79±0.05	3.68±0.04	3.69±0.05
Protein,%	0.5083	3.98±0.04	3.88±0.03	3.89±0.03
Density	0.0401	1.0264^{a}±0.00	1.0268^{ab}±0.00	1.0280^{b}±0.00
Salt,%	0.4923	0.61±0.01	0.59±0.01	0.59±0.01
PH	0.8309	6.80±0.02	6.77±0.02	6.77±0.02
Temperature, ^{o}C	0.1479	32.69±0.26	33.61±0.27	33.73±0.26
Freezing point, ^{o}C	0.7678	-0.47±0.01	-0.47±0.01	-0.48±0.02

^{abc}within the same rows, values with different letters are significantly different at P<0.05)

Some studies stated that nullparous animal produces less milk compared to multiparous that resulted in different milk composition between parities, therefore milk from younger goats tends to have a higher fat content than that from older goats (Idowu and Adewumi, 2017). While Abbas et al. (2014) reported that parity had a significant effect on the lactose content of milk with third parity goats having the highest values.

Lactation stage only affected fat, total solid and density (P<0.05). These findings were in agreement with some literature stated that stage of lactation affected milk composition (Abbas et al., 2014; Getaneh et al., 2016 Idowu and Adewumi, 2017). The lowest fat and total solid was in early lactation and the highest was in late lactation (P<0.01). The pattern of the fat and total solid showed increasing from early to late parity. This resulted from the yield of milk, since there was increasing milk yield in early lactation, and decreasing in milk yield after the peak of lactation at the end of early lactation until the beginning of middle lactation. According to Klir et al. (2015) stated that there was a relationship between changes in yield and composition, when milk production started to decline, fat and protein concentrations again increased. However other properties had no pattern on changes in lactation stage.

There are three main stages of lactation namely early, mid and late lactation, in which milk composition changes markedly during lactation with regard to its basic components, consequently, its physicochemical properties (Idowu Adewumi, 2017). Many studies reported that fat content of milk decreased from the beginning of lactation to a minimum in mid-lactation and continuously increased until the end of lactation (Klir et al., 2015; Getaneh et al., 2016; Wanjekeche et al., 2016).

CONCLUSIONS

Parity order affected fat, total solid, lactose, protein and freezing point of Anglo Nubian x Etawah Grade goat milk. Lactation stage only affected fat, total solid and density. Pattern of fat and total solid in both different parity order and lactation were similar. The lowest fat and total solid in first parity and early lactation and the highest was in third parity and late lactation. Physico-chemical properties of Anglo Nubian x Etawah grade goat milk met the requirement of National Standard of goat milk.

REFERENCES

Abbas, H. M. F. A.M. Hassan, M. A.M. Abd El-Gawad and A. K. Enab. 2014. Physicochemical Characteristics of Goat's Milk. Life Science Journal 11(1s)307-317

FAO. 2015. Food and Agriculture Organization Yearbook 2015. http://faostat5.fao.org/home. (access April 2017).

García, V., S. Rovira, K. Boutoial, M.B.López. 2014. Improvements in goat milk quality: A review. Small Ruminant Research 121 (2014) 51–57

García-Peniche, T. B., H. H. Montaldo, M. Valencia-Posadas, G. R. Wiggans. 2012. Breed differences over time and heritability estimates for production and reproduction traits of dairy goats in the United States. J. Dairy Sci. 95:2707–2717

Getaneh G, Mebrat A, Wubie A and Kendie H. 2016. Review on Goat Milk Composition and its Nutritive Value. Journal of Nutrition and Health Science Vol 3 Issue 4: 1-10

Idowu, S.T and O. O. Adewumi. 2017. Genetic and Non-Genetic Factors Affecting Yield and Milk Composition in Goats. J Adv Dairy Res 5 (2):1-4

Klir, Z., K. Potočnik, Z. Antunović, J. Novoselec, Z. Barać, D. Mulc3 And D. Kompan Milk Production Traits From Alpine Breed Of Goats In Croatia And Slovenia. 2015. Bulgarian Journal Of Agricultural Science, 21 (No 5) 2015, 1064-1068 Agricultural Academy

Kučević, D., I. Pihler, M. Plavšić, and T. Vuković. 2016. The Composition Of Goat Milk In Different Types Of Farmings. Biotechnology in Animal Husbandry 32 (4): 403-412

Kumar S., B. Kumar, R. Kumar, S. Kumar, S. Khatkar and S.K. Kanawjia (2012). Nurtional Features of Goat Milk. A Review. Indian. J. Dairy Sci. 65(4): 266-273

Lôbo, A.M.B.O., R.N.B. Lôbo, O. Facó, V. Souza, A.A.C. Alves, A.C. Costac. 2017. Characterization of milk production and composition of four exotic goat breeds in Brazil. Small Ruminant Research 153: 9–16

Park, Y. W and George F.W. Haenlein. 2017. Overview of Goat milk. Handbook of Milk of Non-Bovine Mammals. 2nd Ed.

Praharani, L. Supryati, and R. Krisnan. 2015. Milk Quality Of Anglo Nubian X Etawah Grade Goats And Saanen X Etawah Grade Goats At First Kidding Period. Proceeding of International Seminar of Animal Production. UGM. Yogjakarta.

Prihatminingsih, G.E., A. Purnomoadi dan D. W. Harjanti. 2015. Hubungan antara konsumsi protein dengan produksi, protein dan lak-tosa susu kambing Peranakan Ettawa. J. Ilmu-Ilmu Peternakan 25 (2):c20 – 27

Setiawan, J., R. R. A Maheswari, B. P. Purwanto. 2013. Sifat Fisik Dan Kimia, Jumlah Sel Somatik Dan Kualitas Mikrobiologis Susu Kambing Peranakan Ettawa. Acta Veterinaria Indonesiana. Vol. 1, No. 1: 32-43

SNI. 1998. Badan Standardisasi Nasional. SNI 01- 3141-1998. *Susu Segar*. BSN. Jakarta.

Sukarini I. A. M. 2012. Produksi Dan Komposisi Air Susu Kambing Peranakan Etawah Yang Diberi Tambahan Konsentrat Pada Awal Laktasi. Majalah Ilmiah Peternakan.

Sumarmono, J. M. Sulistyowati, K. Widayaka, and S. Wasito. 2012. Composition and Processability of PE goat milk. Jurnal Pascapanen Peternakan Vol 1, No 1 (2012)

TAS. 2008. Thailand National Bureau of Agricultural Commodity and Food Standars. Ministry of Agriculture and Cooperativies.

Wanjekeche, E., Z. Macosore, A. Kiptanui1 and T. Lobeta. 2016. Quality And Consumer Acceptability Of Goat Milk With Respect To Goat Breed And Lactation Stage. African Crop Science Journal, Vol. 24, Issue Supplement s1, pp. 95 – 99.

Zuriati, Y., R.R.A. Maheswari dan H. Susanty. 2011. Karakteristik Kualitas Susu Segar Dan Yoghurt Dari Tiga Bangsa Kambing Perah Dalam Mendukung Program Ketahanan Dan Diversifikasi Pangan. Seminar Nasional Teknologi Peternakan Dan Veteriner 2011: 613-619