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## Composition of goat milk in Grenada, West Indies: A preliminary study

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### ABSTRACT

Goat farming is a common practice on the island of Grenada, West Indies. In the years post-Hurricane Ivan (2004), the dairy goat industry has been gradually evolving into a commercial entity, in order to provide goat milk and milk products to the community. Vital to the sustainability of this industry is the maintenance of a high-quality and reproducible product. However, there are no data available on the current composition of goat milk in Grenada. This preliminary study was undertaken to assess the composition of goat milk to assist farmers in the further development of the Grenada goat milk industry. Using a commercial milk analyzer, 115 goat milk samples from four Grenada parishes were analyzed. The results gave an average of dairy goat milk composition in Grenada, including values for fat (4.53%), protein (3.47%), non-fat solids (9.07%), lactose (4.91%), and total solids (13.60%). Milk values were significantly different among the four parishes, with St. Patrick having the lowest values and St. Andrew the highest. Additionally, there was no significant difference between values derived for Grenada versus those recently reported in the neighboring island of Trinidad. The composition of goat milk in Grenada and the differences among parishes is hypothesized to be influenced in large part by nutrition. Future plans are underway 1) to advise goat farmers on the husbandry and feeding of goats to optimize the quality of milk and 2) to perform updated analyses on the milk composition post-implementation.

**Keywords:** Goat, goat milk, Grenada, milk composition

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Grenada—an island country in the southernmost region of the Grenadines (Central Intelligence Agency, 2015)—has both the terrain and climate traditionally considered as favorable for raising small ruminants, including goats (Norton, 1984). Since the devastation of Grenada by Hurricane Ivan in 2004 (World Bank, 2009), Grenadians have been building small-scale goat farms for meat, milk, and milk products, mainly for personal and small group use. With the increasing value and interest placed on

goat milk and milk products, particularly with potential for increased profits and depicted health benefits (Bruhn), larger goat dairy units have been established in the country and have begun collaborating with each other in order to form bigger commercial entities to sell milk and milk products to the community, including goat cheese (Brooks-Smith-Lowe, 2013).

Along with the growth of the goat milk industry in

**Table 1. Number and distribution of Grenada goat milk samples**

Parish	Farm ID	# total goats <sup>*</sup>	# tested goats <sup>†</sup>	# milk samples <sup>‡</sup>
St. Andrew	1	20	10	20
	2	20	6	12
St. David	3	55	7 (1)	13
	4	20	8	16
	5	15	1	2
	6	12	3 (1)	5
St. George	7	20	10	20
	8	25	2 (1)	3
St. Patrick	9	24	12	24

<sup>\*</sup> Column indicates total number of goats on the farm.

<sup>†</sup> Column indicates total number of goats from which milk samples were taken. Numbers in parentheses indicate number of goats for which a sample was obtained from only one quarter.

<sup>‡</sup> Column indicates total number of milk samples obtained per farm.

Grenada is the concern for the creation and maintenance of a high-quality product. It has been well documented that large differences in goat milk composition occur naturally due to factors such as breed, stage of lactation, and both quality and quantity of feed (Haenlein, 2002; Oprean *et al.* 2011). To date, no data are available regarding the composition of goat milk in Grenada. Additionally, there is no standard or even recommended feeding regimen to optimize goat nutrition in Grenada. It is, thus unclear how the composition of goat milk in Grenada relates to neighboring islands, world standards, and within the country itself.

The purpose of this research was to establish a national average of dairy goat milk composition in Grenada through qualitative analysis and to compare values among tested parishes and the national average with the neighboring island of Trinidad (Aphzal *et al.* 2013). Results from our study are reported in this communication.

## MATERIALS AND METHODS

### Ethical approval

The project was approved by Institutional Animal Care and Use Committee (IACUC #13012-R) at St. George's University (SGU).

### Milk collection and analysis

Grenada is divided geographically into six parishes. Nine dairy goat farms from four parishes were randomly selected for this study: two farms from St. Andrew, four from St. David, two from St. George, and one from St. Patrick (Table 1). The parishes of St. John and St. Mark were not included, due to lack of dairy goat farms in these regions. Thorough verbal explanation of the research project was provided to the owner of each farm; and informed written consent was obtained before sample collection. Five milliliters of milk was aseptically collected from both right and left quarters of all available milking goats from each farm. In brief, each teat was first cleaned with 70% ethanol, and the milk sample was collected in a sterile specimen container. Gloves were worn during cleaning and milking. Goats were excluded if they had clinical mastitis or were producing colostrum. If a goat had a dry quarter, or if sufficient milk could not be obtained from one quarter, then only one quarter was sampled. All milk samples were transported on ice to the SGU School of Veterinary Medicine (SGUSVM) laboratories within 4 h post-collection.

Upon arrival at SGUSVM, milk was analyzed for levels of fat, protein, non-fat solids (SNF), lactose, and total solids (TS) using a LactiCheck LC-02 RapiRead Milk Analyzer (Page and Pedersen, Inc, MA, USA) according to manufacturer's instructions. TS were derived for each sample by adding the fat and SNF values. Statistical analyses performed on results included the non-

parametric Kruskal-Wallis test (comparison of values among Grenada parishes) and z-test (comparison of Grenada values to Trinidad). A *p*-value of equal to or less than 0.05 was considered significant.

## RESULTS AND DISCUSSION

A total of 115 milk samples were obtained from 59 goats in nine Grenada dairy goat farms from May – June, 2014 (Table 1). Selected farms had between 12 – 55 goats total (24 – 102 goats per parish); and 1 – 12 goats per farm (23 – 36 goats per parish) were sampled. Two goats from St. David and one goat from St. George had only one quarter sampled. Given that the goat dairy industry in Grenada is still very much in its infancy, the numbers and locations of goats tested in this study are considered relevant sampling for the current study of goat milk composition in Grenada.

Average goat milk compositions for each parish and for Grenada as a whole were determined as shown in Table 2. All tested milk values (including fat, protein, SNF, lactose, and TS) demonstrated statistical differences among the parishes, using the Kruskal-Wallis test (*p* < 0.001 for all values). St. Patrick showed the lowest concentrations for all five tested values, specifically for fat (1.72%). The highest means for all milk values were found in St. Andrew. The average values for Grenada were also compared with milk composition results reported in 2013 from ten purebred Anglo-Nubian goats from Trinidad (Aphzal, Aishah *et al.* 2013). No statistical significance was found between Grenada and Trinidad (Table 3).

Research on goat milk composition has indicated that goat breed, as well as stage of lactation can play a significant role in the composition of milk (Bruhn;

Haenlein, 2002). Although efforts have been underway to import and incorporate better-quality breeds (New Agriculturist, 2010), goats in Grenada are currently a wide variety of breed combinations, including Saanem, Toggenburg, and Alpine (originally from Switzerland); Jamnapari and Nubian (Indian); Anglo-Nubian (English and Indian) and the South African Boer (G. Stratton personal communication April 27, 2015) (David). It is, therefore difficult to compare milk composition of Grenadian mixed-breed dairy goats to purebred dairy goats, including the recent Trinidad study (Aphzal *et al.* 2013) and a 43-year-old Trinidad study on imported Alpine and Anglo-Nubian goats (Devendra, 1972). Regarding stage of lactation, the kidding season for Grenadian goats primarily occurs from January to April (G. Stratton personal communication April 27, 2015). Although predicted that most sampled goats were in late-stage lactation, most farm owners in the current study were unable to provide exact stages of lactation, due to incomplete records. Future studies will be employed to determine the effects of lactation stage among Grenadian dairy goats.

In addition to breed and stage of lactation, previous researchers have emphasized the effects of feed and feeding systems on the composition of goat milk (Morand-Fehr *et al.* 2007; Oprean *et al.* 2011). In Grenada, dairy goats primarily feed by foraging on native plants, which are similar among the four sampled parishes (G. Stratton personal communication April 27, 2015). With emphasis being placed on importing higher-production goats (New Agriculturist, 2010), there is, therefore a problem involving maintaining proper nutrition for Grenadian dairy goats, particularly for upcoming breeds potentially not well suited to a tropical climate (Devendra, 1972; Copland, 1984), although the Anglo-

**Table 2. Composition of Grenada goat milk samples\***

Parish	n <sup>†</sup>	% Fat	% Protein	% SNF	% Lactose	% TS
St. Andrew	32	6.02 ± 1.87	3.59 ± 0.38	9.36 ± 0.99	5.07 ± 0.54	15.39 ± 2.59
St. David	36	5.02 ± 1.68	3.47 ± 0.18	9.07 ± 0.50	4.91 ± 0.28	14.09 ± 1.60
St. George	23	4.61 ± 2.18	3.49 ± 0.43	9.12 ± 1.13	4.92 ± 0.61	13.73 ± 3.02
St. Patrick	24	1.72 ± 0.44	3.28 ± 0.13	8.65 ± 0.36	4.69 ± 0.27	10.38 ± 0.64
<b>Total</b>	<b>115</b>	<b>4.53 ± 2.26</b>	<b>3.47 ± 0.32</b>	<b>9.07 ± 0.82</b>	<b>4.91 ± 0.45</b>	<b>13.60 ± 2.76</b>

\* The means for fat, protein, non-fat solids (SNF), lactose, and total solids (TS) percentage values are shown for each parish ± standard deviation, along with the totals for all four parishes combined. All values (fat, protein, SNF, lactose, and TS) were statistically different among the parishes by the Kruskal-Wallis test (*p* < 0.001 for all milk values).

<sup>†</sup> n, number of milk samples.



**Table 3. Comparisons of goat milk composition between Grenada and Trinidad\***

Milk Parameter	Grenada	Trinidad	z-value	p-value
% Fat	4.53	4.90	0.096	0.92
% Protein	3.47	3.20	- 0.08	0.94
% NFS	9.07	8.70	- 0.07	0.94
% Lactose	4.91	4.80	- 0.03	0.98
% TS	13.60	13.60	0	1

\*Means for tested milk parameter values in all four parishes combined in Grenada were compared against known values for purebred Anglo-Nubian goats in Trinidad (Aphzal *et al.* 2013). No statistical significance was found between values in Grenada versus Trinidad by z-test.

Nubian has been indicated as promising, according to a recent study in Trinidad (Lallo *et al.* 2012). It is commonly recommended that dairy goats be provided supplemental feed to their diet in order to increase the production and quality of their milk (Oprean *et al.* 2011). Already, Farms 1, 7, 8, and 9 provide ruminant concentrate as a supplement to their dairy goats (G. Stratton personal communication April 27, 2015). However, as evidenced by Farm 9, there still seems to be a lack of nutritional support for Grenadian dairy goats.

Efforts were made during the current study to collect and analyze the nutritional value of these native plants on which goats at the dairies were reputed to feed, as well as analyze any supplemental feed offered. It was advised from preliminary findings that the goats from Farm 9 be fed a higher ratio of crude fiber to increase their milk quality (R. Sharma personal communication April 28, 2015) (Morand-Fehr and Sauvant, 1980). Given the farming practices in Grenada, it was not possible during the confines of this study to determine exact types and quantities of all plants and supplements consumed by the goats and make recommendations based on these and the milk composition results. Thus, the differences in goat milk among parishes are not well understood in this preliminary study. Future studies are warranted to better evaluate the exact feed and quantity at each dairy goat farm, correlate findings with goat milk composition, and thus be able to deduce correlations between feed and goat milk composition in Grenada.

This is the first report on the composition of goat milk from Grenada, West Indies. Results suggest performing research to correlate nutrition with production and composition of milk in Grenadian dairy goats is clearly needed. Follow-up studies on goat milk composition and methods by which to improve production and quality will greatly assist the burgeoning goat dairy industry,

as well as the health and welfare of dairy goats in Grenada.

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