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Milk Density in Two Dairy Collection Routes for Pasteurizing Plant in Camagüey

Noemí Fernández Pérez, Gisell Bebert Dorta, Edith Pérez Acosta, Teresa González Compte and Luis M. Navarro Cardoso

Faculty of Agricultural Sciences, University of Camagüey, Cuba

noemi.fernandez@reduc.edu.cu

ABSTRACT

Milk density values were assessed in two dairy collection routes (Route 6 and Purialito) for Pasteurizing Plant in Camagüey, Cuba. The study was carried out in the months of March-April-May, 2013, where 179 samples were assessed, and a density values database was created. A descriptive statistical analysis for density was performed with SPSS 15.0. Using simple variance analysis through a general linear model, the effects of route, month, and their interactions on milk weight, were measured. The multiple comparison test (Tuckey) was performed to contrast density differences between months. Route and month significantly influenced on milk density ($P \leq 0.05$); the same behavior was observed for route-month interaction ($P \leq 0.05$). The mean values and ranges of dairy density were within the normal limits, though in May they decreased to 1.027 g/cm^3. The multiple comparison test (Tuckey) showed significant levels ($P \leq 0.001$) between March and April; and March and May ($P \leq 0.05$); no statistical significant differences were observed between April and May. The better route was Purialito in terms of dairy density.

Key Words: *dairy milk quality, density, month, route*

INTRODUCTION

High grade milk has certain features (Sedesol, 2007), including density, cryoscopic constant, refractive index, titrable acidity, fatty matter, non-fatty solids, leukocyte count, pathogenic microorganisms, inhibiting substances, etc. Density values are produced due to the presence of several milk components diluted or undiluted in milk water, which have changing densities. Among them, fat is the only substance with a density very similar to water. The other milk components are above 1, indicating that below that level may mean water addition; that is, milk dilution. On the contrary, values above normal parameters probably indicate milk with very low fat concentration or skimmed milk, which indicates fraud (Brito, 1995 and Hardin, 1995, cited by González, Molina and Coca, 2010).

The industry and dairy sector´s needs are based on offering consumers reliable and healthy dairy products (Ferraro, 2012). As a result, research and production have been proposing different technologies to measure and assess milk quality, always in the search for the most accurate ones (Cotrino, 2008). The density test is useful to estimate the addition of water and the level of solids in a sample (Sagaró, 2006).

The goal of this paper was to evaluate milk density and the effect of month on two milk collecting routes for the pasteurizing plant in Camagüey.

MATERIALS AND METHODS

This work was carried out at the pasteurizing plant in Camagüey City, Cuba. The study lasted three months (March-May, 2013), coinciding with the end of the dry season and start of spring. Daily milk samples were taken from two milk collection rotes, upon arrival to the plant. Density determination was made by fixed weight volume, using the Quevenne Lactodensimeter at the plant.

The density of 179 milk samples was assessed, which helped create the database with the values achieved. As changing sources, month and route were studied. Descriptive statistical analysis for density was made using SPSS (2006), 15.0. Simple variance analysis was made through a general linear model to measure the effect of route and month, and their interaction on milk and weight. The multiple comparison test (Tuckey) was performed to contrast density between the months.

RESULTS AND DISCUSSION

Milk density determination, according to the route and month

Density, one of milk´s physical properties, has a unique importance due to the direct relationship with milk quality, an especially, because it is one of the parameters taken into account to pay farmers for their raw milk. It changes between the values given above, depending on milk composition, as it depends on the combination of densities and their components, that include water, 1.000 g/cm^3; fat, 0.931 g/cm^3; protein, 1.346 g/cm^3; lactose, 1.666 g/cm^3; and minerals, 5.500 g/cm^3.

Tables 1, 2, and 3 describe the general basic milk density statigraphs by route and month, respectively. The lactometric test to the samples analyzed proves that the density values as a whole averaged 1.0293 g/cm³. For the route values, density in route No. 6 was 1.0291 g/cm³, on average; whereas Purialito was 1.0294 g/cm³.

Moreover, the mean monthly density values revealed milk weight of 1.0295 g/cm³; 1.0291 g/cm³ and 1.0292 g/cm³, for March, April and May, respectively.

Regarding density or specific weight of raw milk, there are varied criteria about what the normal values should be. Cabrera *et al.* (1987) said that in practice it is uncommon for the cow´s milk´s density or specific weight, to go below 1.029 g/cm³, or over 1.34 g/cm³, showing a mean of 1.032 g/cm³. In addition, Sagaró (2006) pointed out that this parameter varies between 1.029 g/cm³ and 1.032 g/cm³ (the most frequently observed is 1.30 g/cm³); Abeledo *et al.* (2007) also noted that milk density values must not be below 1.029 g/cm³, considering it as the lowest.

In Cuba, the Ministry of Finances and Prices established limits between 1.029 and 1.033 g/cm³ (NC 448, 2006); whereas in Venezuela, the Covenin Standard No.903 (1993) set up the physicochemical requisites for raw milk, limiting density between 1.028 g/cm³ and 1.033 g/cm³, at 15 ºC, as minimum and maximum values, respectively. Furthermore, the Chilean Standard No. 1672 (1998), established that milk density must range between 1.028 and 1.034 g/ml, at 20 ºC.

In general terms, the results match the means of milk densities reported in the literature, though the minimum values decreased in May, to 1.027 g/cm³, considered low, regarding the Cuban regulations in place, but considered normal, according to Cabrera *et al.* (1987), who defined the limits for cattle milk between 1.027-1.034 g/cm³. Besides, Brito (1995) and Hardin (1995), cited by González *et al.* (2010), confirmed as natural, the milk density between 1.027 g/cm³ and 1.033 g/cm³. However, the maximum values achieved in the research are somewhat distant from the said higher limits, as they did not exceed a density of 1.030 g/cm³ in any month.

Low density levels may be associated to environmental factors, which according to De Lima *et al.* (2001) have a direct influence on animal consumption levels, giving way to significant variations in milk production and composition.

Another cause for the decline in density may be given by differences found in handling dairies, according to Bennett (2012), who noted that milk quality data may behave in unusual ways; for instance, with extreme variations resulting from specific conditions and practices in each site. Accordingly, several studies on dairy farms have proven that there are variations in comparison with the average for milk density. Páez *et al.* (2002) reported density values outside the set limits, related to more fat content values and the absence of cold, when determining the physicochemical features of raw milk in Aroa and Yaracal, Venezuela. Furthermore, Hernández and Ponce (2005) found milk density averages of 1.0295; 1.030 and 1.029 g/cm³, when assessing this indicator in different groups of dairy cows.

Effects of route and month on milk density

Table 4 shows that that the effect of the route was highly significantly on milk density ($P \leq 0.05$), according to variance analysis.

These results are possibly produced because every route collects the milk from a group of pre-established farms, where several factors effect on quality parameters. In that sense, the dairy industry highlights on good herd handling practices. Milk composition variations have been produced due to human incidence on handling and production.

An assessment of physicochemical parameters of raw milk in two groups of farms in the Pedraza Municipality, State of Barinas, Venezuela, Dulcieri, Guzmán and Zaldívar (2013) found highly significant differences ($P < 0.001$) in terms of density, fat, protein and cryoscopy, indicating that although they had similar zootechnical conditions, there are important differences when comparing these parameters between the farms assessed.

Decreased density values is the direct result of insufficiencies of milk components, especially, protein and non-fatty solids, which may be altered mainly by handling factors and feeding in the dairy areas (Hernández and Ponce, 2003); and also by adding extra water, foreign fats, skimming, addition of solid preservers, and soluble substances (sugars and salts), as noted by Hernández (2003). In either situation, humans play a significant role.

Internationally, the marketing regulations demand placing special emphasis on on-site handling for milk quality. Despite technical advances in industrial processing, milk quality is determined on-site (Bennett, 2012); if after manipulation and transportation, no further difficulties are observed, milk quality should remain unchanged to the plant.

The month effect also showed significance for milk quality ($P \leq 0.05$). These results fully match the results achieved in similar studies in Cuba. Capdevilla *et al*. (2001) found significant differences in season of the year and month of the year, on fat, density, non-fatty solids, total solids and acidity; Hernández and Ponce (2002) determined a significant effect of season of the year ($P \leq 0.01$), with a better behavior of milk components in July and August; whereas Hernández (2005) proved that the season has a direct effect on milk production and composition, by studying several forest-grazing genotypes.

However, when assessing the physicochemical parameters of raw milk, Dulcieri *et al*. (2013) found no statistical variability in milk density during the months of the study, which does not match the research results.

It has been repeatedly said that there is a relationship between season and dairy cow feeding, and milk components and density. Experiments performed in Cuba corroborated that a deficit in nutrients in the diet may induce certain metabolic disorders and alterations in composition and physicochemical features of milk, which resulted in decreased milk density values when protein was reduced in the diet (Hernández and Ponce, 2005), which usually occurs in the dry season, directly affecting pasture yields and consumption by the animal.

The route-month interaction was significant ($P \leq 0.01$) for milk density. Some authors have noted the effect these factors have on milk physicochemical features. In that sense, García (1999) when studying the effects of season and area of origin on the physicochemical features and composition of pasteurized raw milk in Barquisimeto, Venezuela, reported that the season had a marked effect on raw milk composition, effecting highly significantly on the values achieved ($P < 0.001$).

The effects of season of the year; as well as other systems and kinds of feeding, breed, physiological factors, and others, on milk composition are apparent, bringing deterioration of the dairy cow´s health and repercussion in milk solid contribution, especially caused by energy/protein unbalances in the diet (Wittwer, 2000 cited by and Ponce, 2005). These alterations in density decrease are many times reported as associated with the Abnormal Milk Syndrome (SILA) (Ponce and Hernández, 2001; Hernández and Ponce, 2003), where nutrition, genetic potential, health and herd productivity are closely related.

Regarding milk quality variations, credit has been placed to season effects on the values of all milk indicators, and it is explained, according to Capdevila *et al*. (2001), by the idea that the best behaviors are observed in the rainy season, due to more pasture availability and an increase in quantity and quality of the diet (Hahn, 1996; Ponce, 1998 and Villoch, 2002).

However, the difference between means revealed that March had the best behavior, not May (as expected), because the former sets the beginning of the rainy season. Shoots of grass are still incipient and the dairy cows´ nutritional requirements are not fully met.

CONCLUSIONS

Mean values and milk density limits are within normal. The route and month significantly effected on milk density ($P \leq 0.05$), with a significant interaction ($P \leq 0.05$).

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Table 1. Descriptive statistics of milk density (g/cm³) in general

Variable	N	Mean	Typical Deviation
Density	179	1.0293	.0006519
Error Típ.	.0000487		

Table 2. Descriptive statistics of milk density per route (g/cm³)

Route	Density		
	N	Mean	Typical deviation
Route 6	91	1.02915	.0007403
Purialito	88	1.02944	.0005221

Table 3. Descriptive statistics of milk density per month (g/cm³)

Month	Density		
	N	Mean	Typical deviation
March	61	1.02956	.0005039
April	60	1.02910	.0006023
May	58	1.02924	.0007507

Table 4. Variance analysis. Dependent variable: density

Source	gl	Quadratic mean	Significance
Corrected model	5	3.02E-006	.000
Intersection	1	189.465	.000
Route	1	4.08E-006	.001
Month	2	3.49E-006	.000
Route * Month	2	2.15E-006	.003
Error	173	3.50E-006	
Total	179		
Total corrected	178		

R squared = .200 (R corrected square = .176)