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Variation in milk yield and composition in cows in tropic of Veracruz State, Mexico

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Abstract

To analyze the yield and composition of milk under tropical conditions in Mexico in different genetic groups (Holstein, Brown Swiss, Zebu, Tropic Milking Creole and crosses), a retrospective analysis of 1047 cows (11154 records) in 28 herds located in the central region of the Veracruz State, Mexico was conducted during dry and rainy seasons. The Holstein showed higher milk yield with low percentage composition compared with Zebu and Tropic Milking Creole. Milk yield was significantly high in Holstein cows compared to the other breeds. Among the five genotypes, higher fat and protein percentage was found in TMC. Similarly, lactose, non fatty solids and total solids were significantly high in Z and MTC breeds. Except Holstein, all other breeds produced higher milk yield and composition in rainy season. The data provides a basis for the development of standards of quality specifications for tropical milking cows, establishment of payment systems based on protein and other solids.

Keywords: Tropical dairy breeds; milk yield; composition

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Introduction

Milk is one of the staples of human nutrition, supported by the great diversity and assimilation of essential compounds that comprised of proteins, carbohydrates, fats, vitamins and minerals. This food provides about 30% of the protein consumed in developed countries, that's the reason milk is basic subject of studies in the field of genetics, physiology and nutrition (FAO, 2013). By scientific perspective, the physico-chemical properties of milk are very important from the point of view of nutritional capacity (Chung and Norman, 2004).

Fluid milk production in Mexico during 2013 was around 11 million tons and 11.2 million metric tons (MMT) is expected by the end of 2014 according to the official data from the Ministry of Agriculture, Livestock, Rural Development, Fishery and Food (SIAP, 2014). The Veracruz State was ranked sixth in the milk production in the country and first in the category of tropics. Milk production is mainly developed with dual-purpose. Currently, native cattle include Creole and Zebu, pure breed comprised of Holstein, Swiss American, Brown Swiss, Jersey and crosses are *Bos indicus* and *Bos Taurus* in different proportions (Garcia, 2002).

Due to the diversified genetic resources of livestock, the environmental, nutritional and managemental requirements also change (Montero, 2001). In tropical conditions, there are factors such as breed, management, feeding system and stress which affect milk yield and quality. The dry season, low availability and quality of food are the most important factors which affect the physiological balance of the systems involved in the synthesis and secretion of milk (Ponce, 2004).

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Especially in Veracruz and the rest of the Mexican humid tropics regions are lacking a baseline study on the characteristics of the milk composition with no technical criteria for identification of genotypes that can provide higher performance and good quality of milk, in order to achieve the target of developing artisanal cheese and other dairy products. Also, there are limitations to implement homogenous payment systems based on milk quality (Cervantes et al., 2005). This ecological region has about 60% of the cattle population in the country and the predominant farming is dual purpose, in rustic grazing systems and management, along with highly automated intensive systems. The main destination of milk production in this region is to provide milk for artisan cheese factories, sales points of Multinational Corporation (TNCs) and direct sale of raw milk to the population (INAES, 2013). So the objective of this study was to assess the milk production and composition in pure indigenous, cross bred and exotic breeds in the region of Veracruz.

Materials and Methods

Animals

Individual records of 1,047 cows in 28 herds with a total of 11,154 milk production records and composition in the tropical region of Veracruz, Mexico were analyzed. The breeds included Holstein (H), Brown Swiss (BS), Brown Swiss x Zebu (BZ), Holstein x Zebu (HZ), Zebu (Z) and Tropical Milking Creole (TMC). The study involved a retrospective analysis from 2000 to 2014 with an average of ~6 lactations distributed in two seasons (dry, November to May and rainy, May to October). The milking of the cows was either one time (06:00h) or twice (06:00h and 14: 00h). Milking practice includes both mechanical and manual.

Milk samples

Milk samples (10 ml) were collected individually at intervals of 28 days and stored at refrigerator (4°C) temperature until analysis.

Record dairy production and composition

Milk production data were taken from the individual cards for each cow and analyzed for milk composition (fat, total protein, lactose, non-fatty solids and total solids) by Infrared Spectrophotometry (MilkoScan FT120, FOSS®).

Statistical analysis

Data was analyzed with one-way ANOVA using STATISTICA (Version 10.0 for Windows StatSoft, Inc. 2010). Means were analyzed by the Tukey test with a significance level of $P<0.05$.

Results and Discussion

In Table 1, the milk yield and composition in the region of Veracruz are shown. Table 2 showed that yield and daily milk production were significantly high ($P<0.05$) in H cows compared to the other breeds. Among the five genotypes, higher fat and protein percentage was found in TMC. Similarly, lactose, non fatty solids and total solids were significantly high in Z and MTC breeds. This result shows that concentration of fat, total protein, lactose, solids and non fatty solids were characterized by higher values than those set by Mexican standards included in Official Rules of Mexico (NMX-F-443-1983) and reported for cows in similar conditions of management and feeding by Cervantes et al. (2005) and Bonilla et al. (2008). Similar results have also been reported by some other workers (Sutton, 1989; Kennelly et al., 1999; Brülisauer, 2003; Eicher, 2004; Lopez-Villalobos and Garrick, 2004).

Regarding the effect of season, it was found that milk yield was higher in the rainy season in all the breeds except HZ and Z. Studies of Garcia (1999) reported similar findings in Venezuela. The reason of enhanced performance during rainy season may be due to increased availability of pasture and forage during the season in those herds that do not receive additional supplements during dry season and have nutritional imbalances in energy and protein (Ocaña et al., 2003), reinforcing the need to implement measures and develop technologies to secure food in the dry season to improve tropical dairy.

The results shown in Table 3 indicate that lactose component showed variation between seasons and genetic groups. It was significantly high ($P<0.05$) in the rainy compared to dry season except Holstein.

Table 1: Average yield and milk composition in tropical dairy herds from Veracruz State

Variable	Average	Minim	Maxim	S.D.	Average[1]
Yield / lactation (l)	2023	405.4	7429	1697.5	---
Daily production (l)	5.93	1.00	42.1	6.03	---
Fat (g/dl)	3.46	1.96	5.84	0.66	3.0
Protein (g/dl)	3.39	2.62	5.96	0.42	3.2
Lactose (g/dl)	4.73	3.68	9.00	0.46	4.3
Non-fatty solids (g/dl)	8.66	5.19	10.54	0.60	8.3
Total solids (g/dl)	12.29	6.33	18.44	1.12	12.53

SD = Standard Deviation; Average[1] = NMX-F-443-1983. Foods, Fluid milk, Freezing point, Hortvet Cryoscopes, Method of test. Official Rules of Mexico

Table 2: Means analysis of milk composition breed tropical dairy cow form Veracruz State

Variable / Genetic group	H	BS	BZ	HZ	Z	MTC
Yield / lactation (l)	4460±1460[a]	2472±958[c]	2885±1213[b]	2201±650[d]	1407±302[e]	1237±421[f]
Daily production (l)	13.75±7.4[a]	8.00±4.17[d]	5.93±2.93[c]	5.23±2.64[d]	4.92±1.86[d]	3.47±1.46[e]
Fat (%)	3.46±0.44[bc]	3.43±0.43[c]	3.37±0.47[b]	3.51±0.56[c]	3.47±0.47[c]	3.75±0.89[a]
Protein (%)	3.19±0.44[d]	3.30±0.42[c]	3.22±0.38[d]	3.33±0.43[c]	3.44±0.47[b]	3.77±0.61[a]
Lactose (%)	4.55±0.26[d]	4.70±0.32[b]	4.67±0.30[bc]	4.70±0.30[b]	4.88±0.40[a]	4.75±0.36[a]
Non-fatty solids (%)	8.36±0.58[d]	8.59±0.59[c]	8.56±0.63[c]	8.73±0.58[b]	9.12±0.64[a]	9.09±0.62[a]
Total solids (%)	11.95±0.83[d]	12.0±1.07[d]	12.24±0.94[b]	12.47±0.86[c]	13.05±0.90[a]	13.0±0.90[a]

Ranges of values in the second line: minimum and maximum; [a, b, c, d] Different letters between column in the same rows are significant (P<0.05); Holstein (H), Brown Swiss (BS), Brown Swiss X Zebu (BZ), Holstein X Zebu (HZ), Zebu (Z), Tropic Milking Creole (TMC)

Table 3: Milk yield and composition during dry and rainy seasons in different breeds of cows

Genetic group	Season	Milk/ day (l)	Lactose (%)	Fat (%)	Total solids (%)
H	Rainy	14.47±0.31*	4.59±0.020ns	3.35±0.041*	12.04±0.07*
	Dry	12.44±0.32	4.54±0.027	3.54±0.44	11.86 ±0.07
BS	Rainy	8.34±0.31*	4.73±0.025*	3.20±0.04*	12.30±0.068*
	Dry	7.72±0.63	4.63 ±0.025	3.49±0.042	11.75 ±0.07
BZ	Rainy	5.18±0.24*	4.74±0.021*	3.36±0.033ns	12.39±0.048*
	Dry	5.00±0.21	4.61±0.020	3.40±0.029	12.16±0.054
HZ	Rainy	6.28±0.24ns	4.72±0.031*	3.43±0.057*	12.40±0.084 *
	Dry	5.80±0.21	4.65±0.031	3.57±0.050	12.24±0.084
Z	Rainy	4.52±0.57ns	4.76±0.047*	3.53±0.077ns	13.02±0.13ns
	Dry	4.49±0.63	4.86±0.047	3.52±0.085	13.01±0.14
MTC	Rain	4.90±0.40*	4.66±0.035*	3.89±0.05*	13.29±0.09*
	Dry	4.18±0.36	4.39±0.03	4.10±0.05	12.75±0.08

ns = no significant difference; *: P<0.05 between season of the same genetic group; Holstein (H), Brown Swiss (BS), Brown Swiss X Zebu (BZ), Holstein X Zebu (HZ), Zebu (Z), Tropic Milking Creole (TMC)

According to Ponce and Bell (1986) and Vilotte (2002) an explanation of this behaviour may be due to the supply constraints in the dry season, affecting the supply of nutrients, especially glucose but in the case of the Holstein, this impact could manifest itself in both seasons.

Fat percentage was higher in dry season compared to rainy season. It is a common feature in some reports on the subject (García, 1999; De Lima et al., 2001), but not always the same pattern is obtained, because of the relationship of this component to the type of feed and milk volumes (Hernandez, 2004). Milk fat alteration is dependent on the level of lipid supplementation, (Grummer, 1991). Sutton (1989) commented that nutrition offers a means of making rapid changes in milk composition, but the relationship between feed constituents and milk composition is complex. The greatest changes can be brought about in the concentration of milk fat by the amount of roughages, concentrate ratio, intake and meal frequency. In this study, variations that can be found are not significant since the quality of food is not different in two seasons.

Conclusions

If the objective is only the production and sale of fluid milk, Holstein cows showed the best options to provide more volume, but if the objective is sale of milk by solids and/or cheese, the appropriate breeds are Tropic Milking Creole and Zebu.

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