

Evaluation of dairy performance of crossbred (Buffalypso x Carabao) buffalo cows

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Dairy performance of crossbred buffalo cows was characterized using 18 412 milk yields on the test-day and accumulated milk yields (2 575, 1 838 and 1 155) at 100, 200 and 244 d of lactation, respectively. Animals belonged to 37 herds of the Crossbreeding enterprise "El Cangre". The Mixed procedure of SAS was applied to analyze the fixed effects: calving year (7), calving season (2), herd (37), lactation number (9), test-day order (9) and random effect of each animal living in the herd (1377). Yield means on the test-day was 3.4 kg and adjusted to 244 d of 860.3 kg. The first lactation was of lowest yield, with 2.58 ± 0.03 kg on the test-day and accumulated milk yield at 100, 200 and 244 d: 346.6 ± 5.0 kg, 629.2 ± 12.5 kg and 762.1 ± 19.8 kg. Buffalo cows calving in July-October showed the highest yields: 3.27 ± 0.03 kg, 425.9 ± 4.6 kg, 768.0 ± 11.1 kg and 923.8 ± 16.9 kg, respectively. Accumulated milk yield at 244 d was maintained constant from 2004 to 2009. In the studied population there were productive fluctuations associated to the effects of the number of lactation, test-day order, herd, season and calving year. General means were above to what was reported in Cuba in previous studies. However, a tendency towards a productive rise is not described. Genetic and environmental measurements are required to attain better performance.

Key words: *buffalo cows, environmental factors, milk*

In the last decades, buffalo rearing has been an alternative for milk and meat production in the world. The rusticity of these animals facilitates its environmental tolerance and good health, as well as a better use of natural pastures, among other virtues that favor its exploitation and make that the bubaline species turn into an important resource in tropical, subtropical and temperate zones (Fraga *et al.* 2008).

Particularly in Latin America and the Caribbean, bubaline dairy is presently placed as a promissory agricultural alternative in the difficult conditions of economic crisis living the countries of this region (Patiño 2011). It is estimated that in 2025 buffalo population could reach in these territories figures between 12 and 14 millions of animals, a favorable growth demonstrating the advantages of this species for livestock production.

For buffalo exploitation in Cuba, Buffalypso and Carabao breeds were introduced. Buffalypso considered synthetic, has genes of different breeds, making this animal of high hybrid vigor, expressed by an excellent precocity and resistance, desirable characteristics for our environmental conditions. This breed was crossed indiscriminately to the swamp buffalo (Carabao) from Australia, thus, presently there are crossbred animals with variable gradations and phenotypic characteristics.

The knowledge of the productive capacity of our bubaline population is essential for the development of the species and the increase of its productivity. For this reason the objective of this study was to characterize the milk yield performance of crossbred female buffaloes (Buffalypso x Carabao).

Materials and Methods

Data from the dairy productive performance of crossbred female buffaloes (variable gradations of Buffalypso x Carabao) belonging to the Crossbreeding Enterprise "El Cangre" was used. Feeding of the female buffaloes was based on naturalized pastures mainly *Dichantium aristatum* and *Paspalum notatum* and on others introduced as guinea grass (*Panicum maximum*), star grass (*Cynodon nlemfuensis*) and king grass (*Pennisetum purpureum*). The buffalo calf was kept with the dam the first 10 d, and later the dams were incorporated to milking. This was manual, once daily, with the support of the buffalo calf, to which a quarter of the udder was assigned for its feeding. Milk test-day was carried out monthly.

Traits analyzed were: test-day milk yield (TDMY) and accumulated milk yield at 100, 200 and 244 d of lactation (MY100, MY200 and MY244, respectively). Test-day milk yields (18 412) and 2,575, 1 838 and 1 155 observations of accumulated milk yield at 100, 200 and 244 d of lactation, respectively were used. Productions corresponded to 1 377 female buffaloes, pertaining to 37 dairy units with lactation numbers from 1 to 9 for a total de 2 575, corresponding to calvings from the period 2002-2009. For the analysis, the variable calving season was created, sub-divided in two classes, according to the annual frequency of the calvings: in season (July-October) and off season (November-June).

For data analysis MIXED (SAS 2007) version 9.1.3 was used. In the first model test-day milk yield was analyzed. As fixed effects the herd, calving year, calving season, number of lactation and test-day order were considered. The random effect was associated to every

animal within the herd. The second model substituted the test-day milk yields by the accumulated productions in different periods (100, 200 and 244 d of lactation) with the same effects, except the test-day order. The equation of the mixed model (MM) used was the following:

$$1. y_{ijklmno} = \mu + \alpha_i + \delta_j + \lambda_k + \beta_l + \sigma_m + I_n(\alpha_i) + e_{ijklmno}$$

$$2. y_{ijk\ln o} = \mu + \alpha_i + \delta_j + \lambda_k + \beta_l + I_n(\alpha_i) + e_{ijk\ln o}$$

Where:

$$Y_{ijklmno} = \text{test day milk yield}$$

$Y_{ijk\ln o}$ = accumulated milk yield at 100, 200 or 244 d of lactation, respectively

μ = general mean

α_i = fixed effect of the herd ($i = 1, \dots, 37$)

δ_j = fixed effect of the calving year ($j = 2002, \dots, 2009$)

λ_k = fixed effect of the calving season ($k = 1 \text{ y } 2$)

β_l = fixed effect of the lactation number ($l = 1, \dots, 9$)

σ_m = fixed effect of the test-day order ($m = 1, 2, \dots, 9$)

$I_n(\alpha_i)$ = random effect associated to the n-th animal (1, 2, ... , 1377), living within the i-th herd

$e_{ijklmno}$ = normal random error and independently distributed ($0 \sigma_e^2$).

For the significant effects, the multiple range test was applied to the least square means, according to Tukey's-Kramer's test (Kramer 1956).

Results and Discussion

Results from the number of observations, means, standard deviation and coefficients of variation of the accumulated milk yield at 100, 200 and 244 d of lactation (MY 100, MY200 and MY244, respectively) are shown in table 1. Average accumulated milk yield at 100 d was of 403 kg. A similar value was found Méndez y Fraga (2009) in Granma province, Cuba. However, in Venezuela, Montiel-Urdaneta (2008) reported higher values (518.6 kg) with crossbred buffalo cows.

In this study the mean recorded for accumulated milk yield at 200 d of lactation was higher by 117 kg, regarding that obtained in the herd of the Institute of Animal Science (Fraga *et al* 2007). Also, it surpassed by 39 kg that reported at Eastern region of Cuba (Méndez and Fraga 2009). Mainly the measurements of environmental improvements introduced in the enterprise during the analyzed period which contributed to guarantee feed availability, especially during the dry period could account for this result. In this sense,

Table 1. Number of observations (N), means, standard deviation (SD) and coefficient of variation (CV) of the productive characteristics evaluated

Trait	N	Mean (kg)	SD	CV (%)
MY100	2 567	403	97	24.2
MY200	1 838	717	165	23.1
MY244	1 155	860	197	22.9

MY – milk yield

grasslands areas covered with marabou were recovered, and gradually biomass banks with *Pennisetum purpureum* cv. Cuba CT-115, for grazing purposes, and with sugar cane were created. In a lower proportion, silvopastoral systems with *Leucaena* were established and the strategic supplementation was applied. However, the transformations of the feeding basis have not been totally completed in the dairy units of the enterprise.

There was a high variability, according to the standard deviations and the coefficients of variation of the characteristics evaluated. This variability was mainly due to the fact that in this population no directed selections were practiced and, thus, there are animals of variable performance. Also, other genetic factors influenced as the genotype of the female buffaloes (Buffalypso crossbreds) submitted to a low intensity of selection and the use of untested sires for a long period. There were non-genetic effects as the differences in the environmental conditions (feeding basis, animal management and edaphoclimatic conditions) of the different herds during the studied periods.

On analyzing the accumulated milk yield at 244 d of lactation, it can be concluded that it was higher than that reported in Cuba by other authors in studies with this genotype (Méndez y Fraga 2009). Nonetheless, this parameter was lower respecting to that indicated for Murrah breeds in Brazil (Tonhati *et al* 2008) and Mediterranean in Italy (Rosati and van Vleck 2002). Differences in genetic quality of the animals account for these results. Also, the advanced genetic improvement programs that had taking place in these countries as well as the progress in the feeding and management of the animals have also influenced. For example, in Brazil selection studies for milk yield and its constituents have been carried out and advance in the management (buffalo cows submitted to two daily milkings and with supplementation) have been obtained in a ten to twenty year period. All this had repercussion on the significant yield increase in different herds of the country (Tonhati *et al.* 2006).

The exploitation of the Mediterranean breed in Italy is made under stabulation conditions and based on concentrates. The evolution of milk production has been gradual, from 1969 to 1994, as consequence of the increase in the selection intensity through a selection index for kilograms of Mozzarella cheese, which includes the percentage of fat and protein, with the collection and use of ovules and *in vitro* embryo production (Moioli *et al.* 2006). Presently, there are female buffaloes producing more than 5 000 kg in 270 d of lactation. The Artificial Insemination Center, for example, has many bulls with genetic potential, demonstrating the improvement possibilities of this breed, for milk yield and quality (Borghese 2010).

Regarding mean yields in every test-day (table 2) they were approximately 4.03 kg on the first test-day.

The highest yield (4.14 kg) was obtained in the second test-day and the minimum value (2.14 kg) in the ninth which coincided with the end of lactation. Mean yield in the test-day was 3.41 ± 1.30 kg. A similar result reported Mitat (2008) in this same genotype and under similar conditions. Aspilcueta-Borquis *et al.* (2010) obtained higher figures in Brazilian Murrah, an improved breed through the intensification of genetic improvement processes, together with the management and feeding. However, in all the studies there was higher production in the second test-day.

The low productions recorded under this indicator could be due to genetic factors, as the genotype of the female buffaloes submitted to poor selection intensity and the use of untested sires. Also they can obey to non-genetic factors, as the insufficient feeding basis during the dry period and the management of animals. The

Table 2. Number of observations (N), means, standard deviation (SD) and coefficients of variation (CV) on the test-day

Control	N	Means (kg)	SD	CV (%)
1	2 567	4.03	1.14	28.32
2	2 567	4.14	1.09	26.52
3	2 567	3.94	1.08	27.61
4	2 564	3.58	1.13	31.76
5	2 451	3.20	1.12	35.03
6	2 262	2.88	1.09	37.98
7	1 843	2.51	1.03	41.18
8	1 162	2.27	1.08	47.95
9	429	2.14	1.08	50.55

coefficients of variations showed variability between 26.5% and 50.5% and were higher to those reported by Fraga *et al.* (2003) in the same genotype, which can be due to the fact that the study was conducted in a small herd. In both studies there was an increase in the values in the final stage of the lactation, the decrease in the number of observations and the individual differences between animals with respect to the lactation persistency (Tonhati *et al.* 2008) could account for this result. Table 3 shows the analysis of variance demonstrating that the fixed effects of herd, calving year, calving season, number of lactation, test-day order, as well as the random effect associated to each animal living in the herd were significant for the different traits evaluated.

Average performance of test-day milk yield according to the lactation number is shown in figure 1. The lowest yield was found in the first lactation, later there was an increase and the highest productions were obtained in the fourth lactation. Afterwards, it reached a plateau until the ninth.

The first three lactations exhibited significant differences ($P < 0.05$) regarding the rest. This is probably a consequence that growing animals need greater requirements to fulfill their development functions (Afzal *et al.* 2007). Similarly, it could obey to the different ages of the buffalo cow at calving. The highest milk yields were recorded in buffalo cows between 7 and 14 years, and the lowest for young animals and of ages above 14 years (Characo *et al.* 2001). The stable productions, obtained from the fourth lactation, could be of interest for the longevity analysis of buffalo cows and of their permanence in the herd (García *et al.* 2011).

Adjusted means according to the calving season

Table 3. Results of the analysis of variance of the evaluated milk yield traits

Trait	Effect	Numerator FD	Denominator FD	F	Sig.
Test-day	Calving season	1.0	17000.0	36.20	***
	Herd	36.0	17000.0	22.27	***
	Calving year	6.0	17000.0	31.06	***
	Test-day order	8.0	17000.0	1330.14	***
	Lactation number	8.0	17000.0	34.74	***
MY100	Calving season	1.0	1145.0	11.58	***
	Herd	36.0	1145.0	17.89	***
	Calving year	6.0	1145.0	11.31	***
	Lactation number	8.0	1145.0	22.34	***
MY 200	Calving season	1.0	687.0	9.76	***
	Herd	34.0	687.0	15.49	***
	Calving year	6.0	687.0	11.82	***
	Lactation number	8.0	687.0	16.41	***
MY 244	Calving season	1.0	292.0	4.43	*
	Herd	34.0	292.0	13.88	***
	Calving year	6.0	292.0	5.69	***
	Lactation number	8.0	292.0	11.24	***

* $P < 0.05$ *** $P < 0.001$

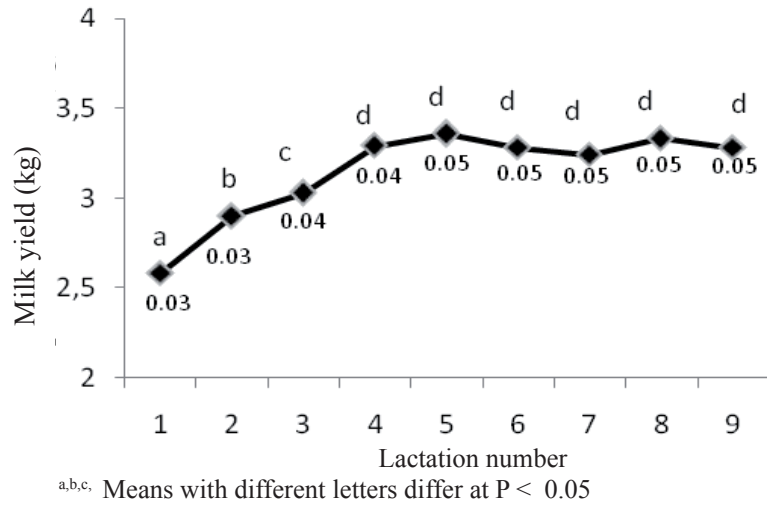


Figure 1. Least square means and SE (\pm) of the test-day milk yields according to the lactation number

are set out in table 4. The highest productions were attained from July to October, where the decrease of the production represented 0.25 kg of milk/d. A similar performance reported Catillo *et al.* (2002) with Mediterranean buffalo cows in Italy and Hurtado-Lugo *et al.* (2006) with crossbreds in Colombia. Results of Fraga *et al.* (2008) and García *et al.* (2010) also revealed a very similar performance to that indicated in the above mentioned studies.

The high seasonal nature of the calvings (85% July-

Table 4 Least square means of the test-day milk yield according to the calving season

Season	Mean (kg/d)	SE \pm
July-October	3.27	0.03
November-June	3.02	0.04

***P < 0.001

October) in the studied population was associated to the climatological conditions. These provide a defined calving period in the months of greater pasture availability in Cuba, which is in line with the rainy season (Ayala *et al.* 1998). This coincided with the period of maximum milk yield in the lactation and supplied greater feeding security for the herds under study. A similar performance was observed in Brazil, with the Murrah breed and its crossbreds (Muñoz-Berrocal *et al.* 2008), where there was a marked seasonal nature of the calvings. In fact, in November-June the availability decreased, influencing unfavorably on milk yield.

Average test-day milk yield according to the calving year (figure 2) was increased, with equal productions in 2006, 2008 and 2009, showing discreet decrease in 2007, which in turn did not differ from 2009. This variable performance demonstrated that in these years the genetic

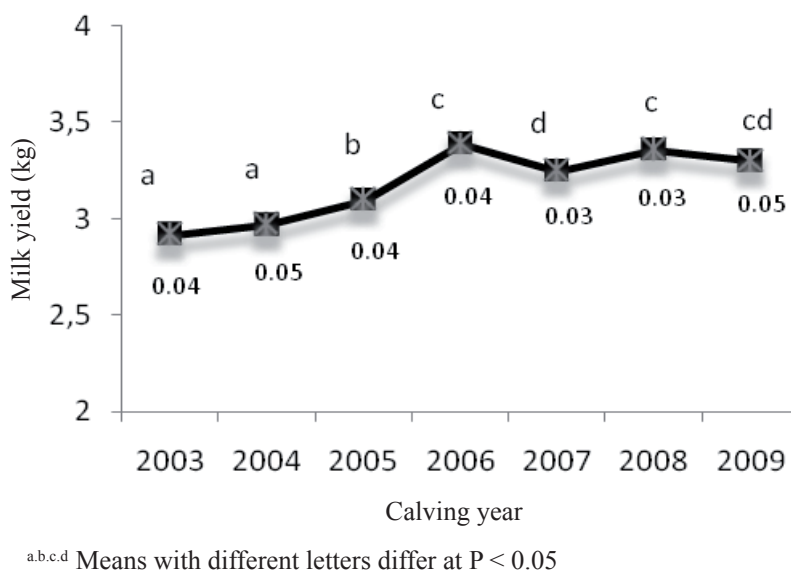


Figure 2. Least square means and SE \pm of the test day milk yield according to the calving year

and environmental measurements were not sufficient to describe a stable tendency of milk yield increase.

The order in which the monthly milk test-day was carried out was different for all the classes analyzed. There was higher yield in the second, and lower in the ninth month. On analyzing the herd effect there was significant herd effect ($P < 0.001$) in the different productions. Ramos *et al.* (2007) found that the herd was the main source of variation of this indicator. In Cuba, in buffalo cows of the Buffalypso breed and its crossbreds, the herd contributed, according to the test-day, between 42.54% and 62.19% of the total variability in milk yield (Mitat 2008).

Changes in the environmental conditions in the different locations among which are feed availability, animal management, climatic conditions and others could account for the significant differences between herds. Also, differences in the genetic composition of the herds, due to their origin and use of direct sire mating could influence.

In table 5 are shown the adjusted means for accumulated milk yield at 100, 200 and 244 d of lactation in the different calving seasons. This factor originated a range of variation of 22, 46 and 48 kg of milk in the different periods. This will represent a significantly

important economical effect, in favor of the July to October season, when there is an increase in pasture yield and quality, regarding the animals calving in the poor rainy months.

The lactation number was one of the factors influencing on these characteristics (figure 3), since until de fourth there was an increase in the accumulated milk yield at 100, 200 and 244 d of lactation. Later, there was a stable performance until the last lactation. The highest productions were observed in buffalo cows with four o more calvings regarding those of one, two and three calvings. This response was due to the fact that first-calving buffalo cows have not yet reached their adult weight and need greater requirements to fulfill development functions. Equally they show poor udder development.

The herd also affected accumulated yields that can be attributed to the differences in the environmental and genetic conditions of the herds during the studied period, a matter reported in the literature (Montiel-Urdaneta 2008).

Results show that there were also productive fluctuations associated to the effect of the calving year (figure 4). Accumulated yield at 100 d increased until 2005. From that year on it was constant until 2009, but

Table 5. Performance of accumulated milk yield at 100, 200 and 244 d of lactation, (MY100, MY200 and MY 244, respectively) according to the calving season.

Season	MY100 (kg)		MY 200 (kg)		MY 244 (kg)	
	Mean	SE±	Mean	SE±	Mean	SE±
July-October	425.9	4.6***	768.0	11.1***	923.8	16.9*
November-June	403.0	7.2	722.2	16.9	875.4	26.8

* $P < 0.05$ *** $P < 0.001$

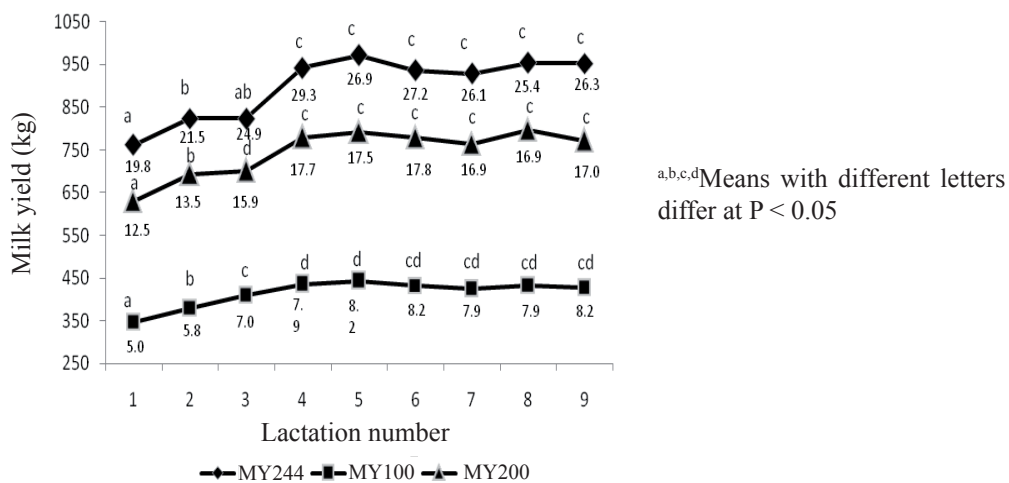


Figure 3. Effect of the lactation number on accumulated milk yield at 100, 200 and 244 d of lactation (MY100, MY200, MY244, respectively)

not differing from the first three years. In the second trait there was a rise until 2006, and fell in 2007, without differing from 2005, 2008 and 2009. Accumulated yield at 244 d was constant from 2004 to 2009, an element that must be considered because it summarizes the productions of previous periods. Similar result was found in studies with buffaloes in India, Pakistan and Brazil (Dutt and Yadav 1986, Singh and Yadav 1987 and Ramírez-Díaz 2009).

Values of accumulated milk yield at 100, 200 and 244 d of lactations ranged since 2003 (393.9, 693.7 and 863.3 kg, respectively) to 2009 (441.4, 786.9, 885.9 kg, respectively). These values can be considered higher to those reported by Méndez and Fraga (2009) in Granma province where they obtained productions of 700 kg.

In general, the stable performance of the production in the last years demonstrated that it is indispensable to increase selection intensity, together with improvements of the feeding basis and the management of the animals allowing the increase of these indicators.

Results show that in the population studied there were productive fluctuations associated to the effects of the number of lactation, herd, season and calving year. General means were above what was reported in previous studies conducted in Cuba. However, a tendency to productive rise is not described. Measurements of genetic and environmental character are recommended to attain a better performance.

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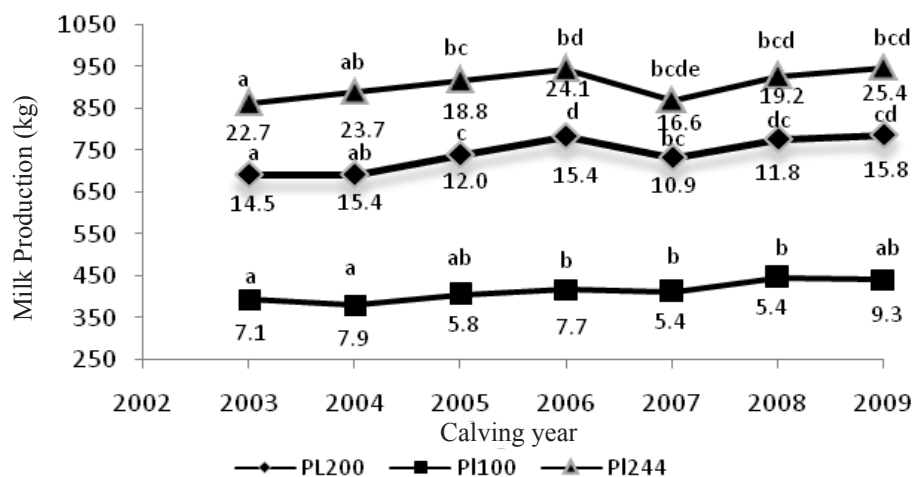


Figure 4. Performance of the accumulated milk yield at 100,200 and 244 d of lactation according to the calving year

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