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Research Article

REPRODUCTION AND PRODUCTION COMPARATIVE ANALYSIS OF F1N'DAMA x MONTBÉLIARDE AND HOLSTEIN IN THE DAIRY STATION OF YAMOUSSOUKRO IN CÔTE D'IVOIRE

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ABSTRACT

The reproduction and production of F_1 N'Dama x Monthéliarde (F_1Monthéliarde) and N'Dama x Holstein (F_1Holstein) were analyzed on dairy station of Yamoussoukro in Côte d'Ivoire. Data collections were done from 2008 to 2016. The average first calving age of F_1Holstein cows was 30.2±5.44 months for the average milk productions of 6.84±2.24 kg/day and 1933±781 kg/lactation (276±35.9 days). These F_1Holstein were more productive than F_1 Monthéliarde (average first calving age was 32.2±4.94 months for milk production of 5.76±2.06 kg/day and 1582±736 kg/lactation in 264±46.5 days).Also, our findings evidenced F1 Montbéliardes cows advantages in term of calving interval period (421±75.4 days) in comparison to F1 Holsteins (453±90.8 days). Otherwise, birth weight of F_1Montbéliardes (females: 31± 1.73 kg;males: 31.7±2.89 kg) was significantly ($p < 0.05$) superior to that theF_1Holsteins(females: 22 kg; males: 23±1.73 kg). But, weight growth showed that the both hybrids had similar growth from 1 to 7 months before observing F_1Holsteingrowth superiority.

INTRODUCTION

Self-sufficiency in milk and dairy products is an issue faced by most countries in the tropics, mainly those of West Africa (FAO *et al*., 2013). In addition to agro-ecological, infrastructural and socio-economic problems (Le Nay and Vatin, 1991; Jan *et al*., 2013), the deficit in dairy production in West Africa is due to the breeding system and low productivity of local breeds (Coulomb, 1976; Osei *et al*., 1991; Youssao *et al*., 2000; Akouango *et al*., 2010; N'Goran *et al*., 2016). To increase productivity, local cattle breed crossbreeding with dairy exotic improved breeds had become a challenge in West Africa. In this dynamic, the *Bos taurus* breeds meanly N'Dama, has always been used in the breeding programs.

N'Dama breed presence in this West African sub region would have been observed 5000 to 2350 BC (Coulomb, 1976). Berber migrations of the 16th century would have favored an important nucleus setting up which would be fixed in mountain massifs of Fouta Djallon in Guinea. It's from this nucleus that N'Dama breed spread in the rest of West and Central Africa (Pagot, 1985)where it acquired best adaptive aptitudes to the climatic and pathological environment (Touré and Hoste, 1987; D'Ieteren, 1994; Epstein and Mason, 1984;Rege and Tawah, 1999; Hanotte *et al*., 2002). Thus, N'Dama is become one of the most cattle local breeds that widely used in crossbreeding programs in West Africa area (Lhoste *et al*., 1976 ; Tamboura *et al*., 1982; Rochemonteix et Muscat, 1984 ; Planchnault *et al*., 1984; Atsé, 1990; Obese *et al*., 2009). But, in Côte d'Ivoire as elsewhere in West Africa, none of those programs have defined reliable strategies for identifying and conserving the obtained results, even less a comparative evaluation of the crossbreds so that recognize the exotic dairy breed (s) which has best aptitudes in crossbreeding with the local breeds. The consequence is that the improved breeds are randomly used in the livestock policy in the incertitude to reach the objectives.

This article proposes to undertake on station a comparative analysis of interest indairy crossbreeding of Montbéliarde and Holstein breeds on the basis on reproduction and production performances of F_1 hybrids N'Dama crossed the both exotic breeds.

MATERIAL AND METHODS

Study site

The study was undertaken in the dairy station of Yamoussoukro (SLY) in the Centre of Côte d'Ivoire. This

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region is located between latitude 06°49 and 06°47 north and longitude 05°16 and 05°15west.The climate of the region is characterized by four seasons (two dry seasons and two rainy seasons) with an average temperature oscillating between 25° C and 38° C and a pluviometer ranging from 900 to 1100 mm per year. The long rainy season goes from mid-March to mid-July and the small season goes from September to mid-November. The dry seasons extend from mid-November to mid-March for the long season and the small season goes from mid-July to August. The vegetation is pre-forest savannah with small trees broken by forest Small Island and with galleries of forest in the lowlands.

Animals and their breeding

The study is focused on the dairy cattle crossbreds F_1N'Dama x Montbéliarde (F_1Montbéliarde) and F_1N'Dama x Holstein (F_1Holstein) from 2008 to 2016. The animals are led in a semi-intensive breeding system. The main food supply is the cultivated pasture (*Panicum maximum K187B* and *Panicum maximumC1* associated to the leguminous plant *Aeschynomene hystrix*) and the natural pasture which the floristic species are not yet identified and characterized. The animals are lead in pasture from 8am to 12am and from 2 pm to 5pm with a rest from 12 am to 2 pm. The complementary foods made up of hay, cotton cattle-cake and of brewery draft are given only during the dry seasons. The licked stone is used for mineral complementation.

The sanitary prophylaxis is done by *Glossina* traps setting and extern deparasity twice per month during the dry season and thrice per month during the rainy season. The extern deparasity start as soon as three months old and keep on every six months. At birth the calves receive an oral suspension of calcium, phosphorus and vitamins and dose of spiramycin. There are after deparasited with the sulfadimerazine 33 during the first weeks of the birth.

Reproduction method

The reproduction way is the natural mating and the artificial insemination. The F_1 heifers were mated when they reached 2/3 of the adult weight. In order to reduce errors in determining the age of sexual maturity and therefore the age at first calving, the first heat of the heifers is detected and mated by N'Dama bulls. Whereas F_1Montbéliarde and F_1Holstein cows were inseminated with Montbéliarde and Holstein semen.

Data recording

The herd is conducted in the pasture by the herd keeper, whereas the technical care taking (rationing, sanitary and medical prophylaxis) is entrusted to breeding technicians. The zootechnical parameters and events regard animals' management, were registered in the different sheets conceived for it. Data collection was done in animal born in the station from 2008 to 2016. The different evaluated reproduction and production parameters are consisting of following: Age at first calving (AFC), Calving interval (CI), Interval between calving-fertilizing insemination (CI-FI), Gravidity length (GvD), Weight, Daily milk yield (DMY), Lactation length (LL), Lactation milk yield (LMY) and Annual milk yield (AMY)

The reproduction parameters were calculated thanks to the above formula:

AFC (month) = birth date - date of the first calving;
CI (day) = date of the last calving-date of previous calving;
IC-FI (day)=calving date-date of the fertilizing insemination;
GvD (day)=date of serving fecundity - date of calving;
DMY=the quantity of milk produced per cow per day (DMY). It was estimated from two milking per day (6am and 4pm).
LMY=date of drying-date of beginning of cow milking
Annual milk yield (AMY) was calculated for records with LMY and CI as (LMY x 365)/CI)

The milk yield were estimated in liter and conversed in kilogram by multiplying per the factor 1.0223 (1 milk liter = 1.0223 kg).

The calves are weighed at birth and monthly thanks to a weighing machine. It takes place the mornings between 6am and 9am.

Data statistical analysis

To appreciate the different studied parameters tendencies, collected data was submitted to descriptive elementary statistical analysis (frequencies calculation, average and standard deviation). The averages of least squares were next estimated and compared by the analysis of variance (ANOVA) with the help of Fisher test to the threshold of 5%. That different analysis was done thanks to XLStat 7.5.3 software.

RESULTS

Reproduction and production parameters

The average value of the reproduction and production parameters of two cows genotypes are summarized in the table1.

Table 1 Arithmetic average reproduction and dairy production parameters of F_1Montbéliarde and F_1Holstein cows

	F_1Montbéliarde			F_1Holstein				
Variables	**N**	**Means**	**LS**	**N**	**Means**	**LS**	***P<0.05***	$\bar{y}_M - \bar{y}_H$
AFC (month)	63	32.2	4.94	49	30.2	5.44	0.036	**
IC (day)	63	421	75.4	49	453	90.8	0.047	**
IC-FI (day)	22	122	43.4	18	131	49.3	0.552	NS
GvD (day)	16	282	15.1	25	286	18,5	0.062	NS
LL (day)	42	264	46.5	33	276	35.9	0.562	NS
DMY (kg)	42	5.76	2.06	33	6.84	2.24	0.032	**
LMY (kg)	42	1582	736	33	19323	781	0.049	**
AMY (kg)	42	1493	833	33	1682	830	0.395	NS

N = number, AFC = first calving age, IC = Interval calving, IC-FI= Interval calving-fertilizing insemination, GvD = Gravidity duration, LL = Lactation length, DMY = Daily milk yield, LMY = Lactation milk yield, AMY = Annual milk yield, LS = Least squares, $\bar{y}_M - \bar{y}_H$ =difference between the arithmetic means of F_1Montbéliarde and F_1Holstein, * significant to the threshold of 5 % ($p < 0.05$); NS: no significant ($p > 0.05$)

Age at first calving

First calving age of F_1Montbéliarde cows did not significantly (p 0.05) differ to that of F_1Holstein (table 1). These parameters varied from 19 to 43 month for the F_1Montbeliarde and from 18.5 to 40 month for the F_1Holstein, with respective variation coefficient of 15.3 % and 18 %. Respect with this parameter the two cow genotypes constituent a heterogeneous population. Figure 1 exhibits distribution of age frequencies at first calving of the both F1 hybrids cows

Interval calving

Interval calving of the F_1Montbéliarde goes from 300 to 712 days for an average of 421±75.4 days. This intervals were significantly ($p < 0.05$) shorter than those of F_1Holstein that varied from 325 to 720 days for an average of 453±90.8 days (table 1). It is between 360 and 420 days for 36.5% of the F_1Montbéliarde and between 420 and 480 for 38.8% of the F_1Holsteins (Fig 2).

Calving -fertilizing insemination interval

Interval between calving and fertilizing insemination of F_1Montbéliarde cows did not significantly (p 0.05) differ to that of F_1Holstein (table 2). This parameter varied from 72 to 280 days for F_1Holstein and from 72 to 235 days for F_1Montbéliardes, with respective variation coefficients 35.6% and 37.8%. Frequencies of this interval grouping classes for these two cow genotypes is exhibited in figure 3.

Duration of gravidity

Duration of gravidity varied from 267 to 345 days for F_1Holsteins and from 268 to 327 days for F_1Montbéliardes with the similar average (table 1). Two cow genotypes frequencies reparation on the variation interval of their gravidities duration is showed in figure 4.

Milk production

Average productions of milk per day and per lactation of F_1Holsteins are significantly ($p<0.05$) superior to that of F_1Montbéliardes. But, these two cows genotype do not show any significant difference in their average annual milk yield and their lactation length (table 1). These milk yields varied from 3 to 12 kg/day and from 586 to 3492 kg/lactation for F_1Holsteins, from 3 to 11.2 kg/day and from 319 to 3360 kg/Lactation for F_1Montbéliardes. Figure 5 and 6 illustrates distribution of the both milk production parameters respect with these two F_1 hybrids cows.

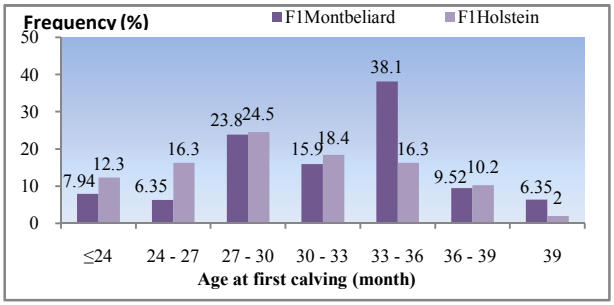


Figure 1 Distribution of the age frequencies at the first calving of F_1Montbéliarde (n = 63) and F_1Holstein (n=49) cows

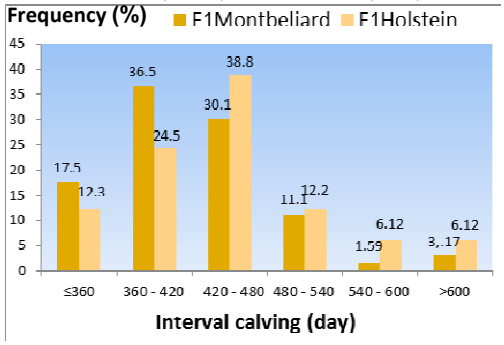


Figure 2 Distribution of interval calving frequencies of F_1Montbéliarde (n = 63) and F_1Holstein (n=49) cows

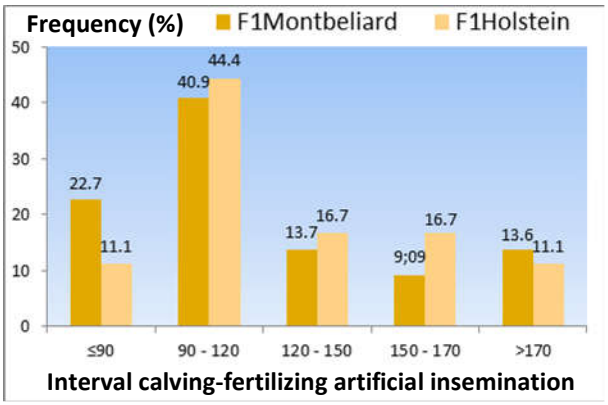


Figure 3 Distribution of interval frequencies between calving and fertilizing artificial insemination of F_1Montbéliarde (n = 22) and F_1Holstein (n=18) cows

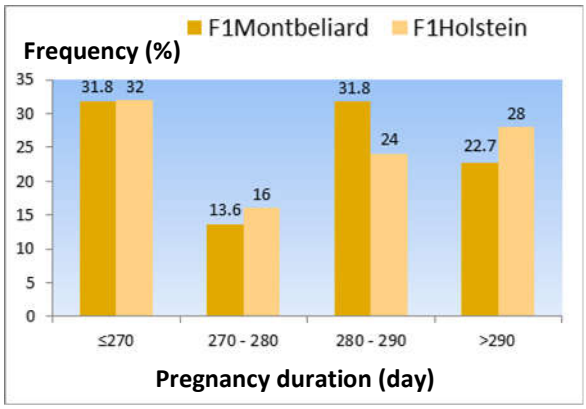


Figure 4 Distribution of duration frequencies of F_1Montbéliarde (n = 16) and F_1Holstein (n=25) cows pregnancy

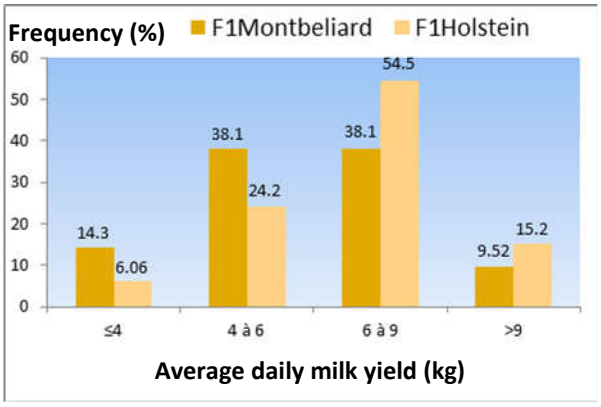


Figure 5 Distribution of frequencies of daily average milk yield of F_1Montbéliard (n = 42) and F_1Holstein (n=33) cows

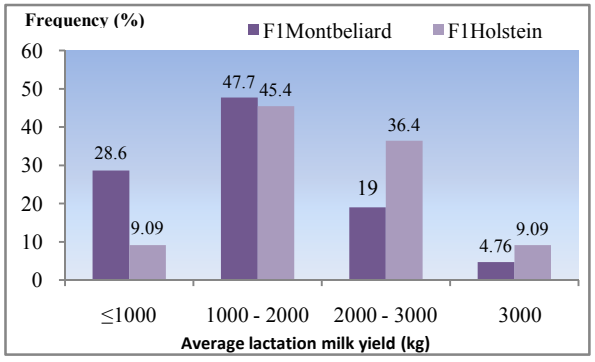


Figure 6 Distribution of frequencies of average lactation milk yield of F_1Montbéliard (n = 42) and F_1Holstein (n=33) cows

Weight at type ages

The table 2 shows the results of the analysis of type age weight variance. These analysis showed that breed had a significant effect ($p < 0.05$) on the weight at birth and at age 9; 15 and 24 months. With an average weight at birth significantly inferior ($p < 0.05$), the F_1Holsteins have weighed at age 9; 15 and 24 months more than the F_1Montbéliardes. At age 9 months, only F_1Holstein males had an average weight statistically ($p < 0.05$) superior than that of the F_1Montbéliardes. Whereas, at age 15 months, only F_1Montbéliarde females had an average weight significantly ($p < 0.05$) inferior to that of F_1Holsteins, and at age 24 months, F_1Holstein females weighed more than F_1Montbéliarde females (table 2).

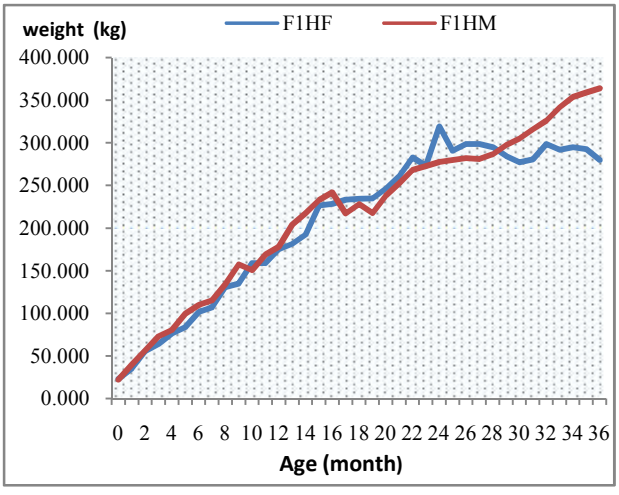
Table 2 Arithmetic average (weights (kg) at different type ages of F_1Montbeliard and F_1Holstein animals

Type age (month)	F_1 Montbeliarde		F_1 Holstein		$\bar{y}_M - \bar{y}_F$
	Female	Male	Female	Male	
Birth	$31 \pm 1{,}73^{a}$	$31{,}7 \pm 2{,}89^{a}$	$23 \pm 1{,}73^{b}$	22 ± 0^{b}	***
3	$55{,}8 \pm 9{,}73$	$72{,}5 \pm 17{,}1$	$63{,}8 \pm 10{,}8$	$72{,}8 \pm 17{,}6$	NS
6	$85 \pm 5{,}29$	$102 \pm 19{,}1$	$101 \pm 13{,}8$	$110 \pm 27{,}5$	NS
9	$125 \pm 19{,}6^{b}$	$113 \pm 24{,}7^{b}$	$135 \pm 22{,}2^{ab}$	$157 \pm 29{,}9^{a}$	***
12	$158 \pm 21{,}1$	155 ± 35	$175 \pm 42{,}2$	$178 \pm 46{,}6$	NS
15	$183 \pm 18{,}1^{b}$	$191 \pm 39{,}6^{ab}$	$227 \pm 20{,}8^{a}$	233 ± 18^{a}	***
18	$205 \pm 22{,}4$	$212 \pm 47{,}2$	$235 \pm 60{,}7$	228 ± 0	NS
21	$235 \pm 28{,}8$	$245 \pm 48{,}2$	261 ± 41	$253 \pm 10{,}6$	NS
24	$262 \pm 28{,}8^{b}$	284 ± 32^{ab}	$319 \pm 21{,}2^{a}$	$278 \pm 3{,}54^{ab}$	***

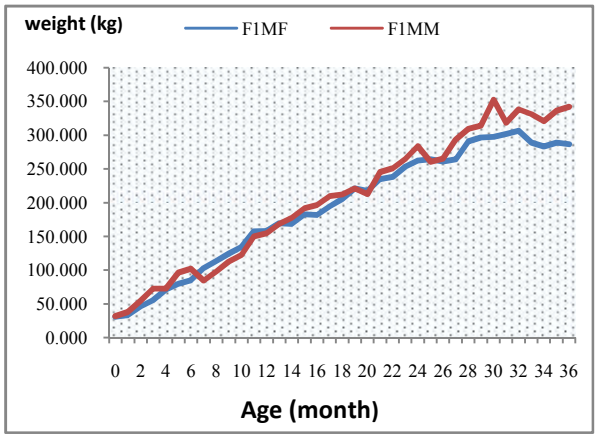
AT = Age type, M = moyenne, $\bar{y}_M - \bar{y}_F$ = différence entre les moyennes arithmétiques des poids des femelles et des mâles, * significatif au seuil de 5% ($P < 0{,}05$) ; NS : non significatif ($P > 0{,}05$)

Weight growth

The comparison of the growth of two cattle genotypes is presented on the figure 7. The averages daily gain of weight (GMQ) have been 235; 287; 238 and 317 $g.j^{-1}$ for F_1Montbéliarde females, F_1Montbeliarde males, F_1Holstein females and F_1Holstein males respectively. Intra-breed comparison showed that females and males animals recorded a similar growth rate from birth to 28th month for the F_1Holsteins (fig. 7A) and from birth to 26th month for the F_1Montbéliardes (fig. 7B). From these dates, the growth rate of the males has been superior to that of the females. The inter-breed comparison showed that with significantly different birth weights (table 2), two cattle genotypes had similar growth from 1 to 7 months (fig. 7C, D, E and F). But, from age 8 to 28 months, the F_1Holsteins growth is begun higher than that of F_1Montbéliardes before to decrease for F_1Montbéliarde females.



A



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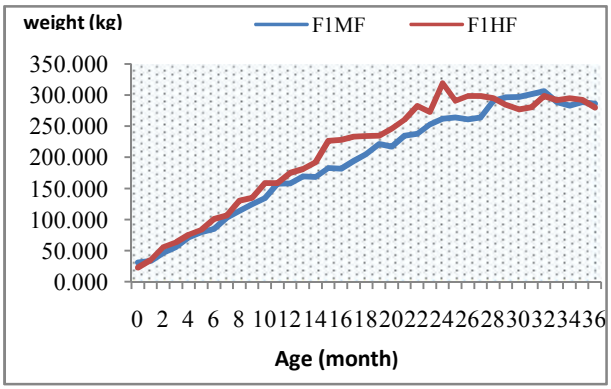

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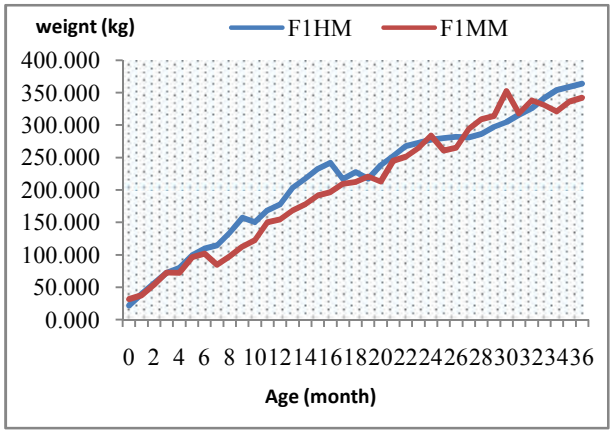

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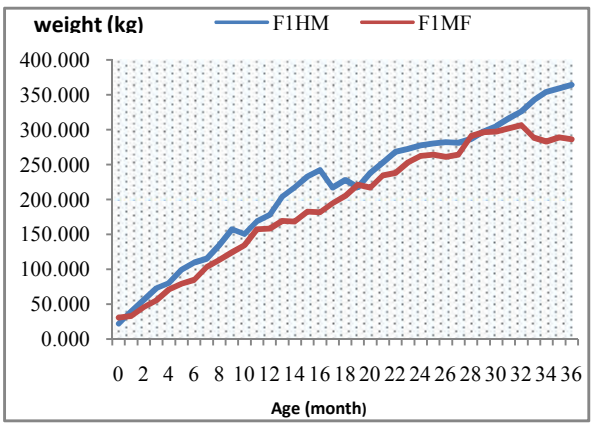

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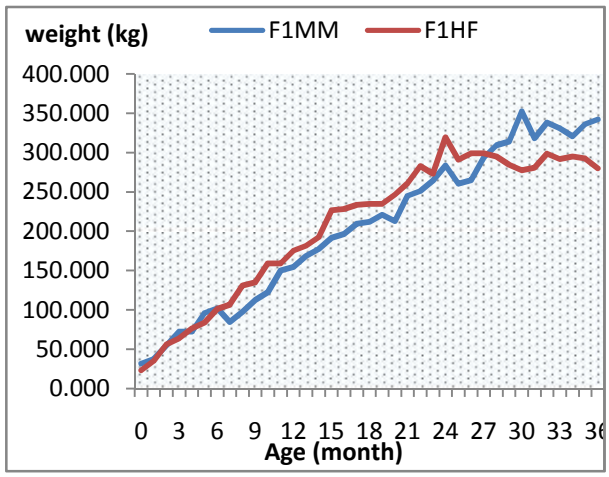

F

Figure 7 Comparative growth curves of F_1Montbéliardes and F_1Holstein

F_1MF : F_1Montbéliarde dame, F_1MM : F_1Montbéliarde sire, F_1HF : F_1Holstein dame, F_1HM : F_1Holstein sire. A : F_1HF compared with F_1HM, B : F_1MF compared with F_1MM, C: F_1MF compared with F_1HF and D : F_1HM compared with F_1MM, E:F_1HM compared with F_1MF and F_1MM compared with F_1HF

DISCUSSION

Analysis of the least squares means of reproduction parameters showed that age at first calving of F_1Holstein andF_1Montbéliardeat the dairy station of Yamoussoukro was on average 30.2± 5.44 month and 32.2 ± 4.94 month respectively. These values are inferior to that obtained for F_1 N'Dama x Jersey (39 months) at CRZ Bouaké (Charray *et al*., 1977), F_1N'Dama x improved breeds (Jersey, Montbéliarde, Rouge des steppes, Pie Noire, Brahman and la Rouge Bulgare) (42.8 months) at Mali (Tamboura, 1982), F_1N'Damance (N'Dama x Abondance) (40.4 ± 1.33 months) and to that observed on farm by N'Goran *et al*. (2015) for F_1Montbéliardes (35.7 ± 0.78 months) in Côte d'Ivoire. The values observed in this study are also superior to that observed for the N'Dama parental breed (ranging from 33.2 ± 5.64 to 43 months)in Côte d'Ivoire (Coulomb, 1976 ; Yapi-Gnaoré *et al*., 1996 ; Sokouri *et al*.,2010 ; N'Goran *et al*., 2016), and at Benin (48 months ±10 days) (Youssao *et al*., 2000). Females precocity observed in present study can be due to the fact constant presence of bulls in the heifers herd when they are reached 2/3 of the adult weight. This weight is reached on average at age 24 months for F_1Montbéliardes and 21 months for F_1Holsteins. This corresponds to an average weight of 264 kg and 261 kg respectively. The presence of males would have a catalyzing effect on female sexual maturity. The best performances of the hybrids can be also explained by the good mastery of breeding conduct technique (feeding, sanitary and medical prophylaxis). The values observed for F_1Montbeliardes in this study are near to this one (33.7 ± 0.35 months) obtained by Rege (1998) from F_1 of *Bos Taurus* crossbreeding with european dairy cattle breeds (Friesian, Jersey, Brown Swiss, Ayrshire and Red Dane) in tropics (Africa, Asia and Latina America). However, this parameter value observed in this dairy station of Yamoussoukro are inferior to this one observed for others cows genetic types used in dairy breeding in Africa. It's about Girolando (5/8 Holstein + 3/8 Gir) (35.3± 0.43 months) at station of Pkinnou at Benin (Doko *et al*., 2012), F_1 Ankolé x Sahiwal (38.3 months) in Burundi (Pozy, 1984). But age at first calving of F_1Holstein is similar to those of F_1Ankolé x Frisian (29.7 months and 29.1 months) in R.D. Congo (Kibwana *et al*., 2012) and in Ouganda (Galukande, 2010) respectively.

The average interval calving of F_1Montbeliarde and F_1Holstein cows of study has been 421 ± 75.4 days and 453 ± 90.8 days respectively. That average interval is longer than the recommended standard value, which is express by "one calf per year", in dairy breeding. But this interval stays similar to those observed on farm by N'Goran *et al*. (2015) for F_1N'Dama x Abondance (F_1N'Damance) (457± 4.85 days), F_1Montbéliarde (434 days) in Côte d'Ivoire, and to the average (415 days) obtained by Rege (1998) from the F_1 of *Bos taurus* x european dairy breeds in tropics. In reference to standard value, prolongation of the interval calving observed at dairy station of Yamoussoukro, corresponds to a performance of 0.87 calve/year, that's a loss of 0.15 calve/cow/year for F_1Montbéliarde and 0.81 calve/year, that's a loss of 0.24 calve/cow/year for F_1Holstein.Thus, F_1Montbéliarde cows would have the advantage to having more calves in plus of milk than F_1Holstein cows. However, the intervals are shorter than that observed by Kibwana *et al*., (2012) for F_1 Ankolé x Frisian (495 days) in R.D. Congo, Obese *et al*. (2009) for the crossbreds Sanga x Holstein-Frisian (510 days) in Ghana and Galukande (2010) for the F_1 Ankolé x Frisian in Ouganda.

The interval between calving and fertilizing insemination was on average 122 ± 43.4 days for F_1Montbéliardeand 131 ± 49.3 days for F_1Holstein.Ideal value of this parameter is 90 days (3 months). This parameter values in present study remain suggestive. Indeed, interval between calving and first insemination was not calculated due to the fact that most cows are not inseminated at 90 days after calving. This lengthens the interval between calving-first insemination and therefore, the interval between calving-insemination fertilizing. However, these values are improved compared to that of N'Dama parental breed (165 ± 15 days) of the same station of Yamoussoukro (N'Goran *et al*. 2016), of Guinea (136 days) and of Congo (165.1 days) obtained in traditional environment by Kamga *et al*. (2006) and Akouandjo *et al*. (2010) respectively.

Analysis of milk production showed that F_1Holstein cows had the averages milk yield per day (6.84± 2.24 kg) and per lactation (1933± 781 kg) superior ($p<0,05$) to that of F_1Montbéliarde cows (5.76± 2.06 kg/day and 1582 ± 736 kg/lactation). These average milk productions per day are near to that of F_1N'Dama x Jersey (5 à 7 kg/day) and F_1N'Damance (6 to 8 kg/day) in station in Côte d'Ivoire (Charray *et al*., 1977; Rochemonteix and Muscat, 1984) and of Girolando cows (5.95± 0.18 to 8.74± 0.21 kg/day and 1367 ± 47.7 à 2230 ± 47.6 kg/lactation) in station at Benin (Doko *et al*., 2012). But, in our study, the both hybrid cows are more productive than F_1N'Dama x Jersey (4 kg/day) in Guinea (Sanyang *et al*., 2004) and F_1N'Dama x Holstein (4 to 5 kg/j) in East Africa (Yemi *et al*., 2004), F_1 Ankolé x Sahiwal (4 kg/day) in Burundi (Hatungumukama *et al*., 2009).

Analysis of weight growth until 24 months showed that F_1Holsteins weigh more than F_1Montbeliardes.This superiority was significantly ($p < 0.05$) marked from the 6th month, although F_1Monthéliardes had a statistically significant birth weight ($p < 0.05$) higher than that of F_1Holstein. This suggests

that Holstein breed crossbreeding with N'Dama breed has good crossbreeding aptitudes for meat production compared to Montbéliarde breed. Moreover, average weights at age 12 months of the crossbreds in present study are superior than those obtained for the crossbreds (144 kg) in Mali (Tamboura *et al*., 1982) and those of N'Dama males (130 kg) in Côte d'Ivoire (Coulomb,1976).

However, we believed that the present survey should be emphasized by including news comparative parameters (mortality at type age, longevity, mothering ability, disease resistance) as well as extended to others exotic improved and/or local breeds in diallel crossbreeding system with the purpose to discriminate exotic breeds that fit better in crossbreeding program in Côte d'Ivoire.

CONCLUSION

To conclude our findings suggested F1 Holstein as exhibiting best dairy trends as well as best weight growth as opposed to F1 Montbeliarde. Although, F1 Montbeliarde claimed a short calving interval time and/or period, Holstein crossbreeding with N'Dama has been recorded as having good aptitudes yielding milk and meat.

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