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DOES CROSSBREEDING BETWEEN EGYPTIAN AND ITALIAN BUFFALOES AFFECT PRODUCTIVE AND REPRODUCTIVE PERFORMANCE?

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SUMMARY

Buffaloes rank universally as the second precious species for milk production. In the last few decades the worldwide total number of buffaloes has increased from 184 to 201 million heads. Despite of the recent reduction (17.76%) of buffalo's population, Egypt still holding the fifth position for the world regarding buffalo numbers. Italian buffaloes produce high milk yield (2,250 kg/lactation) and butter fat (8%), compared to Egyptian buffalo (1850 kg milk/lactation) in conventional herds and 1960 kg milk/lactation in modern dairy herds. Improving buffalo performance is a significant issue that should be achieved via genetic selection, crossbreeding and good management. First cross (F_1) between Egyptian and Italian buffaloes (50% Egyptian and 50% Italian) and backcross (BC) (75% Egyptian and 25% Italian) produced higher milk yield than pure Egyptian buffaloes (PE) and BC was the best compared to F_1 and PE (2511·59kg of milk/lactation). Also, BC showed signs of robustness at the different temperature-humidity index (THI) levels similar to PE. They had the lowest non-conceived percentage after first insemination, with the best rate of delivering live calves and easy calving at various categories of THI. BC buffaloes are more tolerant to the challenging Egyptian environmental conditions. This may be attributable to that BC buffaloes have a higher percentage of the Egyptian blood and consequently are more adaptable to the Egyptian environment.

Keywords: Egyptian buffalo, Italian buffalo, crossing, productive and reproductive performance

INTRODUCTION

Buffaloes:

Domestic water buffalo (*Bubalus bubalis)* is classified into river and swamp buffaloes. The river buffalo is chiefly present in India, the Mediterranean, Caribbean countries and Africa, while the swamp buffaloes are restricted to Asia principally China, India, Philippines, Vietnam, and Bangladesh (Kumar *et al*., 2007). The river buffaloes are preferred to be used for milk production than for meat or draft (Nam, 2010). In the last few decades the worldwide total number of buffaloes has increased from 184 to 201 million heads (FAOSTAT, 2019). Despite of the recent reduction in buffalo population, Egypt still holding the fifth position of buffalo numbers after India, Pakistan, China and Nebal. Dairying in Egypt represents an imperative role stands for approximately 47 % of food supply from agriculture enterprises (RAC/CP, 2002). The average of milk consumption in Egypt is around 61.8 kg/capita/year (FAOSTAT, 2015), comprising the raw milk and products, like butter, cheese and yogurt (LACTIMED, 2014), but, still lesser than the mean world consumption (100 kg/capita/year).

Buffaloes rank universally as the second precious species for milk production (Han *et al*., 2012; Coroian *et al*., 2013) that yield high-quality milk with relatively high fat, protein, lactose, mineral content, but affords only 13% of the total world milk consumption due to small animal population relatively low milk yield (Liu *et al*., 2017). Nevertheless, buffaloes produced low milk quantity when compared to the dairy cows. However, buffalo milk price is roughly three times that of lactating cows (Rosati and Van Vleck, 2002). Buffalo milk presents the first choice in several countries as it is greatly prized owing to its pure white color, rich fat and satisfactory flavor (Abd El-Salam and El-Shibiny, 2011). Further advantage, buffaloes are more capable of transferring low-quality forages with low digestible features to milk or meat when compared to cows (Ibrahim, 2012). Socio-economically, water buffalo is deemed a most critical species in developing countries, like Egypt, which develops the life aspects of farmers (Aggarwal and Upadhyay, 2013).

The concurrent temperature weather temperature, relative humidity, solar radiation and heat stress in tropical and subtropical countries form imperative restrictions on animal performance (Marai *et al*., 2009). The summer temperature in Egypt is depicted as moderate to high with moderate humidity levels. Dairy animals could be drastically influenced by heat stress as a result of harsh hot and humid climate as of Egypt, which consequently, influence the welfare, health, survival, reproduction and production of these animals (Dunn *et al*., 2014). However, buffaloes have extraordinary ability to endure the adverse environmental circumstances with a distinguished longevity (approximately ten years; Dunn *et al*., 2013). Egyptian buffaloes resist diseases and adapt to

the restricted environmental circumstances. They exceed cows aptitude to adapt in hot and humid conditions of muddy and swampy lands (Vale, 2007), and still perform well in very hot weathers of tropics and subtropics (Marai and Habeeb, 2010). The adaptability factor is much higher for buffalo than for Friesian cow (Marai *et al*., 2009).

Italian buffaloes are possibly the exclusive to have massive availability of databases regarding genetic structure, applied knowledge, inspection of pathologies, hygiene and products quality (Allam *et al*., 2015). They produce the highest milk yield (2,250 kg/lactation) and fat % (8%) in the world (Varricchio *et al*., 2007; Allam *et al*., 2015). In Egypt, buffaloes produce an average of 1850 kg milk/lactation period (6.3 kg/day) in conventional herds and 1960 kg milk/lactation (7.1 kg/day) in modern dairy herds (Borghese, 2010; Ibrahim, 2012).

Improving buffalo performance:

During the coming two decades, the world population of buffaloes is expected to be notably enlarged due to the growing demand for high-quality dairy products with attractive and competent characters (Castellano *et al*., 2019). This augments the necessity for research, intending to multiply milk precious elements to devoid shifting in manufacturing eminence. Therefore, an imperative need for applying a better and more proficient production development is necessary. Escalating milk production is the principal rational of selection in dairy farms; accordingly, the foremost aim in buffalo breeding is to intensify their future production performance (Nasr *et al*., 2016). The procedure of improving buffalo breeds is enormously convoluted, as selection for a single trait possibly will consequence a negative effect on milk quality in addition to the reproduction (Barros *et al*., 2014). Egypt undergoes a massive production gap in milk and meat production as observed in their annual importation. Buffalo couldn't plug this gap as a result of the lack of specialized breeds for meat/milk production. Therefore, there is a necessity for adopting national genetic upgrading programs.

Enhancing buffalo performance is crucial and ought to be done via selection and genetic development (Fooda *et al*., 2011a). The moderate heritability of milk production, revealed that it will respond to direct mass selection (Malhado *et al*., 2013). Due to this, little exchange of breeding buffaloes among countries, resident populations have distinct phenotypic characteristics and performances (Khan, *et al*., 2011). Crossing Swamp and River buffaloes seems to be a prospective vital approach to achieve genetic improvement (El-Shamaa *et al*., 1997), due to introducing genes of high milk yield into the Swamp buffalo to be used as a triple-purpose animal to produce milk in addition to meat and work. Artificial insemination is a feasible technique to aid plans for upgrading buffalos' performances. Genetic upgrading via crossbreeding and selection should be applied together with good management to enhance the animal performance.

Although Egypt possesses large number of buffaloes compared to Italy, but production/head is much lower. Italy has spent massive efforts in constructing, designing selection and breeding plans and developing feeding strategies (Borghese, 2010). The current research is an endeavour to adopt similar steps to cross the pure Egyptian buffaloes (PE) with the exotic Italian or Pakistani buffaloes, with a general objective aiming at enhancing the production performance and reproductive efficiency of Egyptian buffaloes. In 1980, the Animal Production Research Institute (APRI) imported Pakistani buffalo semen for the purpose of increasing milk yield of local buffaloes. In 2003, Ministry of Agriculture permitted the commercial introduction of Italian buffalo semen that was arbitrarily utilized on large scale in buffalo farms. The introduction of these foreign buffalo breeds was performed with an intention to improve the genetic structure of the Egyptian buffaloes for the economic traits, as was done with the indigenous dairy breeds.

Impact of crossing on buffalo production:

There have been conflicting arguments concerning the impact of crossing PE with Italian buffaloes. Some researchers perceived no difference in the performance of the Egyptian buffaloes due to crossing science their performance was comparable to that of other breeds, and claimed that the introduction of foreign buffalo breeds will not play a significant role in changing the genetic makeup of the Egyptian buffaloes as was in case of the native cows. Others have reported that crossing with Italian buffaloes would improve the performance of Egyptian buffalo breeds (Fooda *et al*., 2011a; Allam *et al*., 2015; Nasr, 2016a, 2017a,b). Allam *et al*. (2015) compared the milk yield of Egyptian buffaloes and Egyptian-Italian crosses and detected minor increase in milk yield due to crossing. Crossbred buffaloes had 24 days longer lactation period, with 5-6 liters more daily milk yield (during the whole lactation period) compared to Egyptian buffaloes. The fat, SNF and protein percents were 3.75, 1.5 and 0.47%, respectively higher, but SCC were lesser in crosses than that of Egyptian buffaloes. Moreover, the Egyptian buffaloes revealed 14.29% mastitic cases/lactation period and 4.29% were diagnosed with diarrhea, compared to 2.86% mastitic and absence of diarrhea in Egyptian- Italian crosses.

Crossing Egyptian with Pakistani buffaloes revealed an increase in milk yield compared to the pure Egyptian buffalo which exhibiting positive impact of crossbreeding with Pakistani buffaloes on milk production. Nasr (2016b) compared the milk production of first cross (F_1, 50% Egyptian and 50% Italian) and back cross (BC, 75% Egyptian and 25% Italian) with the pure Egyptian buffaloes (PE) and reported that F_1 and BC producing high average daily milk yield than PE (9.57, 9.84 and 8.03kg,

respectively) and has also, similar trend for peak milk yield (15.31, 14.03 and 12.99kg, respectively), due to the positive correlation between the two traits (Phathodiya *et al*., 1999). All peak yields (8-12kg) were higher than those reported by Thiruvenkadan *et al*. (2014) probably due to the different genetic background and the better feed quality (Hamid *et al*., 2003). Furthermore BC produced 2511·59kg of milk/lactation that was 103 and 235kg higher than F_1 and PE production and also 0·87 and 1·05 kg of milk/day higher than F_1 and PE daily yield, respectively (Nasr, 2016a). Increasing the percentage of Egyptian blood as in BC group increased the adaptability coefficient to the local environment (Fooda, *et al*., 2011a). Moreover, BC showed signs of robustness at the different THI levels, similar to PE (Nasr, 2016a). They could endure the rough circumstance and become more accustomed to the hot Egyptian weather due to the higher percentage of Egyptian blood in BC (Fooda, *et al*., 2011a).

Impact of crossing on buffalo reproduction:

Reproductive performance has an immense influence on the profitability of the dairy animal production (Berry and Cromie, 2009). There have been incompatible outputs concerning the effects of crossing between pure Egyptian and Italian buffaloes on reproduction. Some researchers perceived no evidence of affection on reproduction and others have reported that crossing with Italian buffaloes improved the reproductive performance of Egyptian buffalo breeds (Nasr, 2016a,b, 2017a,b; Allam *et al*., 2015). Calving interval, service period and days open were longer in F_1 (Egyptian× Italian crossbred) buffaloes than those of PE with age at first calving being 28 and 32 months, respectively and reproductive performance of PE surpassing F_1 (Fooda *et al*., 2011b; Allam *et al*., 2015).

Calving interval is one of the fundamental reproductive parameters, which govern the herd reproductive performance as the shorter the interval, the larger the number of lifetime progeny delivered for each female buffalo (Ramos *et al*., 2006). Calving interval of PE was between 395-418 days (Fooda *et al*., 2011b; Nasr, 2017a), while for F_1 and BC were shorter than that for pure Italian buffaloes (Partha, 1970). The average number of services per conception was 1.9 for PE (Damarany *et al*., 2013), but improved recently by crossing. Back-crossed buffaloes had the lowest non-conceived percentage following first insemination (OR=0.74 with 95% confidence interval [0.66–0.83]) (Nasr, 2016b). BC had the best conceived rate post the first insemination at various THI categories (low 72.20%, medium 72.60%, and high 62.40%) than that for PE which was 63.50%, 69.30% and 59.40%, respectively. Also, BC group had the highest rate of live calves delivery (98.50, 100 and 99.40%) and of easy calving (98.50, 100 and 99.40%) as compared to PE and F_1 at various levels of THI, respectively (Nasr 2017b).

For a dairy enterprise to be successful, restricted better management regime to guarantee calf survival must be followed. Stillbirth in buffaloes is a major recurring reproductive problem that represents virtually 42.3% of the whole reproduction disorders (Ilieva and Peeva, 2008), but may vary from herd to herd. It was 0.09% in rural environment (Prasad and Prasad, 1998), while was 0.67 to 9.2% in farms (Parekh and Singh, 1981) and it was up to 34% for Pakistan buffalo (Hashmi *et al*., 2013) and 13.90% in Egypt (Nasr, 2016b). Economic losses caused by stillbirth cases incorporate calves death (Maizon *et al*., 2004), dam mortality, reduced survivability and premature culling which elevates the cost of veterinary assistances (Szücs *et al*., 2009). Crossing however, may form a solution to overcome some of the above mentioned issues. Crossing between PE and Italian buffalo (F_1 and BC) had lower rate of calving difficulty (OR=0.34 [0.25–0.47] and OR=0.18 [0.14–0.24], respectively) with smaller rate of stillbirth (OR=0.43 [0.35–0.54] and OR=0.06 [0.04–0.10], respectively) when compared with PE (Nasr, 2016b). In addition, BC and F_1 had a lower rate of stillbirth at 2^{nd}-4^{th} and 5^{th}-7^{th} parities than that of PE (Nasr, 2017a). Surprisingly, PE has the highest stillbirth odds ratio (Nasr, 2016b). The general causes of variation may be due to the anatomical dissimilarities of pelvis size, ileum area (Kodagali, 2003), vaginal canal and vulvar lips width (Agarwal and Tomer, 1998), moreover to that PE revealed the heaviest calf weight (40.48 kg) when compared with F_1 and BC (39.86 and 39.87 kg, respectively) (Nasr, 2016b).

CONCLUSION

In conclusion backcross towards PE was comparable to F_1 for production and to PE for reproduction performance. Moreover, it revealed the lowest incidence of calving difficulty and stillbirth in concurrence with the best conception incidence after first insemination. Therefore, BC can withstand the challenging environmental conditions in Egypt and stillbirth without deterioration in production and reproduction performance compared to PE.

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