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Effect Of Milk Yield Level at High Lactation Period on Milk Components, Some Reproductive Traits and Progesterone Hormone Level in Recently Imported Friesian Cows

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Abstract: This study examined the relationship between milk production levels and various reproductive characteristics in pregnant Friesian cows (4.4–4.6 months of gestation). Among the 124 cows transported from Slovenia to Egypt, thirty pregnant cows were selected for this research. Three groups of pregnant Friesian cows were created. The first group consists of ten cows with high milk output (average milk yield greater than 15 kg/day). The second group consists of ten cows with medium milk output (10–15 kg/day on average). Ten cows in the third group have low milk yields (less than 10 kg/day on average). The daily adjusted (fat-4.0%) milk and milk components were estimated. Reproductive qualities (age at later artificial insemination, pregnancy period, age at first calving, gestation period) were also measured. The level of the progesterone hormone was also determined in the serum. The amount of milk production has a substantial ($P<0.001$) influence on all of the milk component yields. Milk production has a significant ($P<0.05$) effect on milk fat content. The percentages of milk components, however, are independent of the amount of milk produced. The heifers' age at the last artificial insemination, age at calving, duration of gestation, and pregnancy period were all unaffected by milk output. Progesterone levels in the medium milk yield cow and the low milk yield cow were considerably ($P<0.001$) lower and significantly greater, respectively, in the high milk output cow. It is concluded that genetics determines milk production levels rather than environmental factors.

Keywords: Milk yield, milk composition, reproductive traits, age at first calving

INTRODUCTION

The combined influences of genotype and environmental factors produce the yields of farm animals. Optimizing the environmental circumstances and enhancing the genetic profile of the animals are both required to improve the yield level. Genetic makeup, environment, illnesses, nutrition, time of year, and calving season all have an impact on milk production. In addition, factors such as breed, age, lactation stage, parity, and frequency of milking can influence milk supply (**Cooke *et al.*, 2013**). There is much debate about the possible conflict between high milk yield and reproductive efficiency, and the main question is whether dairy cattle fertility has actually decreased with high milk production (**LeBlanc, 2010**). Milk production and reproductive effectiveness are the two influences that are necessary the extreme effect on the profitability of dairy cows. Some researchers reported that there is a negative relationship between milk yield and key reproductive indices. Numerous articles discuss the decline in fertility in high-yielding cows. Experts are deeply divided over the potential conflict between great milk manufacture and reproductive effectiveness (**LeBlanc, 2013**). According to the vast majority of research, high milk yield and great fertility in nursing dairy cows are physiologic needs that are in opposition to one another, and genetic selection tactics that are in opposition to one another are inherent antagonists (**Atashi *et al.*, 2021).** Higher milk yield is phenotypically and genetically linked to decreased reproductive performance in lactating cows, according to correlations between reproductive features and measures of milk yield (**Nebel and McGilliard,** 1993). The later authors also reported that low conception rates and delayed ovarian activity are two ways that the demands of a large milk supply affect the success of reproduction. However, recent analyses have discovered that there is not always a conflict between reproduction and production (**Ebrahim and Genina, 2020**). In herds that are expanding and becoming more productive, it can be challenging to fulfill the dietary and interactive requests of high-performance animals, nevertheless similar best management practices can be applied to meet the goals of high productivity, effective reproduction, and cow welfare (**Campbell *et al.*, 2009 and Bello *et al.*, 2012**). Blood levels of the hormones somatotropin and prolactin, which stimulate lactation, have increased while insulin, which is an antagonist of lactation and may be essential to optimal follicular growth, has reduced as a result of selection for high milk supply. Higher milk output is encouraged by these changes in hormone concentrations, but if lactation management is insufficient to satisfy the metabolic needs of lactation, it might remain theoretically harmful for physiological functions, especially reproduction (**Nebel and McGilliard, 1993**). The amount to which negative energy balance impacts gonadotropin

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secretion, which in turn influences ovarian production of progesterone and affects the appearance of estrus and maintenance of the uterus during early pregnancy, appears to depend on the timing and amplitude of negative energy balance (**Nebel and McGilliard, 1993**). Circulating progesterone is critical for embryo growth and establishment and maintenance of pregnancy. The goal of this study is to determine how milk production levels impacted certain reproductive traits, milk constituents and progesterone level.

MATERIALS AND METHODS

Experimental location

This study was conducted in a private farm in New Salahiya, Sharkia Governorate, Egypt during April, May and, June, 2023.

Experimental ethics

Ethics explanation for animal research post-conduct is No. 24A/23 at 21-03-2023.

Animal, feeding and housing

The database was assembled from 124 pregnant Friesian cows transported to the Egypt from Slovenia. The database that accompanied the animal sheet contained information on milk components and some reproductive traits of the first-lactation parity. Among the 124 cows, thirty pregnant cows were selected for this research. Friesian cows reach the top of their lactation at eight weeks after calving.

Concentrate feed mixture and rice straw is given to all animals. The concentrate feed mixture contains clover hay (40%), wheat bran (25%), yellow maize (15%), soybeans (10%), molasses (5%), bone meal (2.5%), calcium carbonate (1%), sodium chloride (1%), and a vitamins and minerals premix (0.5%). According to the chemical analysis, CP, CF, Ether extract, NFE, and ash had respective DM percentages of 18.5, 12.5, 3.5, 56.0, and 9.5%. Animals are provided with free access to rice straw.

Animals are housing in a separate open yard under natural condition. Veterinary doctors are responsible for the care of animals while director of farm is responsible for the care of animals.

Experimental design

In this investigation, thirty pregnant cows imported recently were used, including three groups: First group: ten cows have high milk production (average milk yield greater than 15 kg/day). Second group: ten cows have medium milk production (average milk yield between 10 and 15 kg/day). Third group: ten cows have poor milk production (average milk yield less than 10 kg/day).

Parameters measurements

- Daily corrected (Fat-4.0%) milk and milk components (fat, protein, lactose, ash, total solids and, solids not-fat contents) were estimated.
- Reproductive traits (Age at later artificial insemination, pregnancy period at top lactation, age at first calving, gestation period) were also measured.
- Five mL of blood were withdrawn from each animal in sterile tubes without anticoagulants and centrifuged at 3000 rpm for 25 minutes to obtain serum. The level of the progesterone hormone was determined in the serum using the radioimmunoassay (RIA) method in coated tubes with a commercial kit. After the incubation period, the fluid components in the tubes are evacuated and the radioactivity of the labeled iodine was counted employing a computerized gamma counter in the Biological Applications Department of the Nuclear Research Centre of the Egyptian Atomic Energy Authority.

Statistical analysis: The general linear models of the SAS software were used to analyze the data.

RESULTS AND DISCUSSION

Effect of level of milk yield on milk composition

The least squares mean for daily milk yield at top lactation were 16.64±0.32, 12.64±0.17 and 9.38±0.06 kg for high, medium and low yielding heifers, respectively. The yields of milk fat, protein, lactose, ash, total solids, and solids-not-fat are all significantly (P<0.001) impacted by the quantity of milk yield. The proportion of milk fat is significantly (P<0.05) influenced by milk output. Milk fat and milk quantity are inversely proportional. However, the percentages of milk protein, lactose, ash, total solids, or solids-not fat are unaffected by the quantity of milk produced (Table 1).

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Table 1: Effect of level of milk yield on milk composition of Frisian heifers

Milk yield and composition	Level of milk yield (MY) at top lactation			P values & significant
	Low MY (less than 10 kg/day)	Medium MY (more than 10 and less than 15 kg/day)	High MY (more than 15 kg/day)	
Daily milk yield (kg per cow)	9.38[c]±0.06	12.64[b]±0.17	16.64[a]±0.32	P<0.001
Daily corrected (Fat-4.0%) milk	9.33[c]±0.05	12.74[b]±0.11	17.20[a]±0.12	P<0.001
Milk fat content (%)	4.02[a]±0.06	3.93[ab]±0.03	3.87[b]±0.01	P<0.048
Milk fat yield (g/day)	375[c]±6.28	497[b]±5.38	644[a]±7.55	P<0.001
Milk protein content (%)	3.37±0.03	3.38±0.04	3.30±0.03	P<0.179[NS]
Milk protein yield (g/day)	316[c]±7.96	427[b]±10.50	549[a]±6.69	P<0.001
Milk lactose content (%)	4.70±0.04	4.69±0.05	4.66±0.04	P<0.791[NS]
Milk lactose yield (g/day)	441[c]±5.56	593[b]±12.41	775[a]±12.79	P<0.001
Milk ash content (%)	0.76±0.01	0.78±0.01	0.76±0.01	P<0.457[NS]
Milk ash yield (g/day)	71[c]±1.45	99[b]±2.55	126[a]±4.65	P<0.001
Milk total solids content (%)	12.85±0.11	12.86±0.11	12.59±0.07	P<0.099[NS]
Milk total solids yield (g/day)	1205[c]±21.56	1626[b]±27.62	2095[a]±26.57	P<0.001
Milk solids not-fat content (%)	8.83±0.06	8.93±0.09	8.72±0.07	P<0.155[NS]
Milk solids not-fat yield (g/day)	828[c]±13.28	1129[b]±22.55	1451[a]±22.59	P<0.001

a, b ...Means in the same raw having different superscripts differ significantly

The quantity of milk yield has a major effect on the yields of milk fat, protein, lactose, ash, total solids, and solids-not-fat. The amount of milk produced has a major impact on the percentage of milk fat. The percentages of milk protein, lactose, ash, total solids, and solids-not-fat are all unaffected by the amount of milk produced. Milk fat and milk quantity are negatively correlated.

It is well known that non-genetic factors such as calving year, calving interval, season, parity, age of cows, food, housing, climate change, disease, days from parturition to first service, days open, number of services per conception, and management variables are important for milk yield (**Cobanoglu and Kul, 2019).** Polish Holstein-Friesian Black and White dairy cows were used in **Jówik *et al.* (2012)** investigation on the impacts of two separate milk yield levels: medium (7000 kg per lactation) and high (10,000 kg per lactation).. The authors discovered that the high group had fat-corrected milk, fat, and protein yields higher significantly than those of the medium group by about 52.0, 27.0, and 43.0%, respectively. However, the high group had significantly less fat (3.30±0.21 g) than the medium group (3.90 ±0.23 g), and there were no differences in the amounts of milk protein (3.40±0.23 g vs. 3.22± 0.22 g) across the groups. High-yielding cows' energy requirements during the height of lactation are greater than their intake of net energy from food. This happens as a result of postpartum appetite loss and an increase in metabolic activity, which necessitates a lot of substrates for the synthesis of milk components.

Effect of level of milk yield on some reproductive traits and progesterone hormonal level

The age of the heifers at the time of the last artificial insemination, pregnancy period, age at calving, and gestation length were unaffected by the level of milk yield. However, progesterone hormone levels were affected by the level of milk yield. Progesterone level in high milk yield cow was higher significantly (P<0.01) than the cow with medium milk yield by 14.59% while the cow with medium milk yield was higher significantly (P<0.01) than the cow with low milk yield by 21.22% (Table 2).

Table 2: Effect of level of milk yield on some reproductive traits and progesterone level in Frisian cows

Reproductive Traits and progesterone hormone in pregnant Friesian cows	Level of milk yield at top lactation			P values & significant
	Low MY (less than 10 kg/day)	Medium MY (more than 10 and less than 15 kg/day)	High MY (more than 15 kg/day)	
Number of cows	10	10	10	
Age at later (AI) (months)	14.55±0.67	15.54±0.43	14.48±0.44	P<0.298[NS]
Pregnancy period (PP) (months)	4.58±0.36	4.35±0.34	4.67±0.29	P<0.772[NS]
Age at first calving (AFC) (months)	23.89±0.66	24.91±0.43	23.79±0.42	P<0.259[NS]
Gestation period (GP) (days)	280.10±0.46	281.10±0.64	279.30±0.83	P<0.175[NS]
Progesterone hormonal level (ng/ml)	127.25[c]±2.25	154.25[b]±3.40	176.75[a]±4.09	P<0.001
Progesterone level increase, %		21.22	14.59	

AI=Artificial insemination, MY=Milk yield.

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The results showed that the age of the heifers at the time of the last artificial insemination, pregnancy period, age at calving, and gestation length were unaffected by the level of milk yield. Age at first calving (AFC) is a component of the environment that influences milk yield (**Ojango and Pollott, 2001**). One characteristic that is unique to a population of cows is the AFC. This age varies depending on the country, from 24 to 26 months in Great Britain to 26 months in the Czech Republic to 25 to 27 months in the USA and 28 months in Italy for the Holstein-Friesian breed (**Cooke et. al., 2013**). According to **Wathes *et al.* (2008**), various performance characteristics are regulated by heifer growth rates, which in turn have an impact on AFC, an AFC of 24 to 25 months was linked to the highest reproductive and first lactation yield. According to the findings of **Atashi *et al.* (2021**), a longer first calving interval was related to an increased AFC. The total cost of rearing dairy replacements is heavily influenced by age at first calving, with older calving heifers costing more to rear than younger heifers. For Holstein-Friesian cattle, the first calving should occur at around 24 months old in order to maximize productivity and reduce heifer-rearing expenses (**Krpalkova *et al.*, 2017**). AFC has an impact on the genetic advancement and economic success of dairy cows, according to a study by **Sawa *et al.* (2018**). The authors found that cows in the high age group produced more milk fat and true protein than those in the medium and low age groups, and that the AFC at around 23.3 months was related to decreased milk and milk component output. The age of the female calf at AFC, which is the time period she needs to reach puberty and reproduce for the first time, has a substantial impact on the cost of producing replacements in dairy herds. According to **Ettema and Santos (2004),** the ideal AFC for Holstein dairy heifers is between 23 and 24 months of calving, which is the time period she requires to achieve puberty and reproduce for the first time. According to **Hussein and El-Agawany (2009**), Holstein heifers under Egyptian conditions generally had a mean age at first calving of 26.68 months. According **to Pirlo *et al.* (2000**), AFC has an impact on milk yield returns and raising expenses, as well as milk production and composition. The authors also demonstrated that AFC has a beneficial impact on milk yield and fat percentage while having a negative impact on protein percentage, and they came to the conclusion that the greatest positive impact was shown between the ages of 23 and 24 months at first calving. **Ebrahim and Genina (2020)** investigated the impact of milk production on productive and reproductive traits. The results showed that the heritability of reproductive and productive characteristics changed depending on the levels of production and led to the finding that, despite the fact that the heritability of reproductive traits improved in the low-production group, the heritability estimates of the productive traits of the high-yielding group grew and declined in the low-production group. The authors came to the conclusion that the overall least square means for daily milk yield, lifetime milk yield, total milk yield increase with increasing levels of milk production, with the exception of the lactation period, which shortens with increased level of production. AFC greater than 24 months considerably adversely affected the cow's productive life, cow efficiency index, total lactation time, daily milk output, and total dry periods, according to **Almasri *et al.* (2023).** For cows with an AFC of 24 months or less, the productive life and cow efficiency index were greater, since the productive life and cow efficiency index peaked at 60 months and 69.1 percent, respectively, and then rapidly declined until they reached 48.7 months and 52.6 percent for cows with an AFC of ≥ 36 months. The significant impact of AFC on both the productive life and cow efficiency index is that cows that calved for the first time earlier began their productive lives earlier than those that calved more recently. Additionally, since the latter group of cows had poor reproductive and productive performance, they were also removed from the herd earlier than the former group **(Almasri *et al.* (2020)**.

In contrast, Holstein cows that had their first ca lf at lessthan 24 months of age had a shorter productive life (64.8 months) than those that had their most recent calf at over 31 months (70.8 months) according to resea rch by **Adamczyk *et al.* (2017). Valchev *et al.* (2020)** found that Bulgarian Holstein cows having their first calf at 24 or 37 months had the shortest productive lives (48.4 and 46.8 months, respectively), while their productive lives were optimal when their AFC was between 28 and 30 months. Heifers at this age have appropriate mature and fit physical body condition scores for life, according to the authors

Progesterone levels considerably rose in correlation with cows' milk output. The results revealed that the high milk production cows had much higher progesterone levels than the medium milk yield cows, and that the medium milk yield animals had significantly lower progesterone levels than the high milk yield cows. It can conclude that progesterone concentration increased significantly in line with the amount of milk production in Friesian cows. The primary role of the corpus luteum is to create progesterone, a steroid hormone required for initiating and maintaining pregnancy as well as for the development of embryos in all domestic animals, including cattle (**Bazer, 2013)**. Progesterone is predominantly produced in the corpus luteum by processes that change cholesterol from high-density lipoprotein to progesterone (**Wiltbank *et al.*, 2014).**

Highlight

- The yields of milk components are significantly impacted by the quantity of milk yield.
- While the percentages of milk components except fat are unaffected by the quantity of milk produced.

- The age of the cows at the time of the last artificial insemination as well as age at calving, pregnancy period and gestation length is unaffected by milk yield.
- The level of progesterone concentration directly relates to the amount of milk produced.
- Genetics determines milk production levels rather than environmental factors.

CONCLUSION

It is can concluded that the yields of milk components are significantly impacted by the quantity of milk yield. While the percentages of milk components except fat are unaffected by the quantity of milk produced. The age of the cows at the time of the last artificial insemination as well as age at calving, pregnancy period and gestation length is unaffected by milk yield. The level of progesterone concentration directly relates to the amount of milk produced. Genetic factors determine milk production levels, not environmental factors.

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Author's contribution statement: All authors were participated to complete of this manuscript and all authors have directly participated in the planning, execution and analysis of this study. All authors also have read and approved the final version submitted.

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