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INFLUENCE OF DIETARY MANIPULATIONS AND MILKING FREQUENCY ON PRODUCTION OF DAIRY COWS

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ABSTRACT: Dairy cow responses to various types of diets differently and dairy farmers can use knowledge of its behavior to improve the cow well-being and yield. This review was carried out in order to better understanding the influence of dietary manipulation and milking frequency on the dairy cows' production. The results obtained from review of already conducted studies revealed that the dairy cow is significantly affected by composition, quality, amount and regimes of the diet. Maximum daily milk production, milk protein, milk lactose, milk fat, total solids are recorded in dairy cows when *ad-libitum* feed and water is provided. Further, sufficient water intake is necessary for maintaining body fluids and proper ion balance, digestion, absorption, metabolization of nutrients, elimination and body cooling. Feeding and water frequency stimulate the mammary functions and milk synthesis, which is actually a non-invasive method. Reducing feeding frequency from 2x daily to 1x daily decreases milk yield from 7 to 38% in dairy cows, however changing feeding frequency from 2x to 3x daily results about 18% increase in milk production that can be economically acceptable. On the other hand, increasing milking frequency from 2x to 3x daily increase milk production up to 30%. Therefore, in addition of dietary manipulation and milking frequency, high quality feed and *ad-libitum* water plays always a key role for improving the performance and production of dairy cows.

Keywords: *Ad-libitum*, Diet, Performance, Production.

INTRODUCTION

Dairy cow responses to various types of diets differently and dairy farmers can use knowledge of animal behavior for improving the well-being and yield of cow. For instance, feeding and watering systems must be placed appropriately. Accessibility of feed and water may be more important than the actual amount of nutrients provided (Wilde et al., 1987; Erickson and Kalscheur, 2020). Efforts must be made to reduce the competition for feed, water, minerals, and shelter. Also, cow space, cow density, and distribution of feed and water are closely related factors. Feed intake and consequent milk yield are improved by provision of feed on cows need and want to eat (VanBaale et al., 2005). When one cow eats, another might be stimulated to do likewise, whether she is hungry or not. This behavior is an example of social facilitation when cows eat in groups; they eat more than when they are fed separately. Furthermore, cows kept in groups are likely to be less fearful, and hence, more contented, healthier, and more productive. The common practice of feeding and milking cows in groups thus has a sound psychological basis (Thokal et al., 1985).

Water is an essential component to sustain life and optimize growth, lactation, and reproduction of dairy cattle. However, unlike the careful and continuous attention paid by dairy producers and nutritionists to other nutrients in the ration, oftentimes the quality and provision of free drinking water does not receive the attention necessary to ensure optimal nutrition and cattle performance. In high producing dairy cows, the water requirement is greater compared other land based animals (Tyrrell et al., 1982). This higher need is actually related to large quantity of milk which actually contains 87% water. In addition, water is also used up in digestion, metabolism, circulation, excretion, ionic balance, fluid balance etc. (Stelwagen et al., 1994). Adult dairy cattle contain 56 and 81% water in the body depending on lactation cycle. Loss of even 20% water is considered fatal (Thokal et al., 2004). In order to produce optimum milk dairy cows must drink sufficient amount of water and the feed. The quantity of water which a dairy cow would consume, is largely depends on the environmental temperature, types of consumed feed, amount of milk production and the water temperature (Tulloh, 1966). Water need is directly related to the dry matter intake. Increased intake of dry matter results increased water consumption (Negrao et al., 2001). Keeping in view the importance of diet in life of dairy cow current study was planned, whereby the main objective was to understand the dietary influence on dairy cows worldwide.

INFLUENCE OF WATER FREQUENCY ON THE PRODUCTION OF DAIRY COWS

Water constitutes 60 to 70 percent of the body of dairy cow. Water play role in the cows body such as ionic balance, digesting, absorption, metabolization, excretion, maintaining body fluids balance, thermoregulation, transportation of nutrients. The water need of cows is fulfilled by drinking and metabolic resources. Metabolic water is produced as a result

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of oxidation of organic compounds. Saliva, urine, feces, and milk are main routes whereby water is lost from the body of dairy cows. In addition to that some water is also lost through sweating, evaporation and the respiratory tract. The quantity of loss of water from cow's body is related to the activities performed the animal, temperature and humidity of air, respiratory rate, water and feed intake, and milk yield etc. (Pearson et al., 1979).

It has been revealed that water need of a high producing dairy cow is significantly higher compared other land mammals. It is because of fact that cow produces a large quantity of liquid milk, which actually contains 87 percent water. In order to produce such as higher amount of liquid product, dairy cows must need sufficient supply of water in the diet otherwise their production will severely be impaired (Meyer et al., 2004). Several studies have been conducted on different regimes of water supply to the dairy cows. In a study, some researcher indicated that dairy cows contain 56 and 81% water in their body. Water supply on *ad-libitum* not only supports in maintaining their total body water but also increases the milk production (Little et al., 1976). Few other reported that dairy cows in early lactating stage have higher body weight compared to later lactating stage (69% versus 62%). This change in body weight is actually related to the water level in their body. It was depicted that in early stage (1st lactation) milk production of dairy cows remain significantly lower compared to late lactation (3rd lactation). During early stage water supply on *ad-libitum* is stored in the body tissues which cause overall increase of body weight (Li et al., 2005). Few others reported that 2/3 of body water is found in the intracellular spaces, while 1/3 water is found in extracellular compartments, connective tissues, blood, digestive tract. Water present in the GIT ranges from 15 to 35% of total body weight. However water supply through drinking source play key role in maintaining these water levels in different parts of body (Linzell, 1966).

In another study, researchers observed residence time of water in the rumen of dairy cows (lactating) which was found 1 hour. It was further revealed that when water reside the rumen for long period, it helps in digestion that results higher milk production. They indicated that dairy cows produced higher milk yield on *ad-libitum* water supply compared two times/day water supply (Knight et al., 1992). Some others showed that daily water loss through milk represents 26 and 34% of total water intake (Hale et al., 2013). Water loss through feces ranges from 30 to 35% of total water intake in dairy cows. Loss in urine ranges from 15 to 22%. Cows though were provided water on *ad-libitum* coped excellently with these water losses from body. Further, fecal water loss increases with the increase of dry matter level feed and forage content of the diet. Urinary excretion of water is positively correlated to the water availability, absorption from GIT, urinary N, Na and K excretion (Jurjanz et al., 1993). Further it was found that water loss is also concerned to saliva production, sweating and respiratory evaporation. However, amount of water loss through these routes is dependent upon environmental temperature (Khan et al., 2003; Hernández-Castellano et al., 2019).

Daily water intake and need of dairy cows is influenced by several factors such as quantity of milk production, quantity of feed intake, physiological state, body size, level of activity, environmental temperature, air movement, diet composition etc. In addition to these, other main influencing factor has been reported is frequency and periodicity of watering. Water need of dairy cows is mainly met by drinking source. However, drinking of water is associated with feed supply (Khan et al., 2012). Dry matter content in feed significantly affects the total water consumption by dairy cows. When dry matter content in diet is declined from 50 to 30 percent then consumption of water by dairy cow reduces by 42 percent (Hansen et al., 2007). In study water consumption by lactating dairy cows was studied with respect to pastures. It was noticed that dairy cows consume less quantity of water when fed on green pastures. Further, diets with high level of sodium salts or protein stimulate water consumption in dairy cows (Silanikove et al., 1995).

In another research, it has been stated that higher dry forage diets increase the water requirements. It occurs due to significantly higher excretion of water in feces. They further depicted that there is direct correlation between dry matter and water intake in the dairy cows. When water consumption is below normal level, feed intake decreases. However, if water consumption is normal then cow take dry matter as per its need in order to maintain normal performance, growth, lactation and pregnancy (Carruthers et al., 2015). It has also been studied that water quality is quite important for appropriate water consumption by dairy cows. Water quality in term of odor, taste, presence of toxic elements, physical and chemical state, level of macro and micro-minerals, and microbial contamination. These all contribution factors in combination have direct influence on the acceptability of water, by dairy cows. Total dissolved solids, sulfate sulfur, nitrates, chlorides, iron, and fluoride are primary factors which influence the water quality for dairy cows (Chamberlain et al., 2011). Higher than normal level of mineral elements, microorganisms, and other toxic compounds cause deleterious effects on dairy cows (McGuffey, 2017).

INFLUENCE OF FEEDING AND MILKING FREQUENCIES ON THE PRODUCTION OF DAIRY COWS

In order to maintain regular and consistent lactation, appropriate feeding is the basic need of dairy cows. Minor changes in the feeding significantly influence the normal physiological processes as well production of dairy cow. Altering feeding frequency although appears so simple concept, but it has been reported main contributing factor for reducing the production of dairy cows (Archer, 2013). The influence of changing the frequencies of feed on milk production is variable depending the ability of individual animal to persist itself in the harsh condition. Studies have shown that reducing of feeding frequency from 2 times/ day to 1 time/ day considerably reduces the milk production (7 to 38%) in dairy cows and also increases the loss of udder tissue (AspMisra and Singh, 2012). It has also been reported that increase of milking frequency from 2 time/day to 3 times/day increases the overall milk yield (7 to 20%) (Banerjee, 2009). The exact

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mechanism behind the increase in milk production have not been elucidated yet, but some investigators reveal that the increase in milk production is actually related to increase in mammary epithelial cells, increased cellular activity, reduced apoptosis in mammary epithelial cells and frequent removal of feedback inhibitor of lactation from mammary gland. However feed supply play key role behind these mechanisms (Andrew et al., 2014).

As per previous reports of scientists increasing of feeding frequencies enhances the functioning of mammary cells though in combination supports the milk synthesis in the udder. Increase in milk production is achieved when there is little loss of body condition, while condition loss remains minimum when extra nutrients need of cow is being met by increased feed intake through increased feeding frequency (Amos et al., 2015). This argument is further supported by a study which revealed that milk production on 1 time/day feed supply remains significantly ($p<0.05$) lower compared to 2 times/day and 3 times/ day feed supply (Blake and Custodio, 2014). Some other scientists reported that varying feeding frequency from 2 times to 3 times per day in cattle results increased milk production by 18%. In another study researchers revealed that production of diary cos increases by 20% when feeding frequency is changed from 2 times/day to 3 times/day. Further it was revealed that the lactation period has significant ($p<0.001$) influence on overall milk production of dairy cows. On every next day of milking, production decreases by 2.5ml (DePeters et al., 2015). This concept was further supported by another scientist who depicted that milk yield of dairy cows declines gradually after peak period (Devendra, 2014). The decline in the milk production is mainly related to the sloughing of secretory tissues as well as decreased secretion rate/ mammary cell. In animal is non pregnant then reduction in milk production after reaching to peak period remains gradual, with average 5% reduction in every next month (Stelwagen et al., 1994). In another research it was reported that the dairy cows milked 6 times/ day consume higher quantity of dry matter compared to those who were milked 3 times/ day (Bell, 2011). In the follow up of this research, few others stated that significant increase in feed intake occurs when feeding frequency is increased that ultimately favors the rise in milk production of dairy cow (Erdman and Varner, 2015).

In another study it was noticeable that, with the progression of lactation most of the animals do not gain weight. In fact, loss of body condition occurs during the lactation period especially when animals are milked thrice a day. This indicates that dairy cows have higher dry matter need with higher milking frequencies (Franchi et al., 2019). This study was supported by another research, where researchers indicated higher intake of dry matter by cows when milked 6 times per. Increased milking times causes failure to compensate increased energy demands, therefore dairy cows continuously lose their body weight. On other hand lower body weight loses occur when cows are milked 3 times/day as that provide longer recovery period for better production (Senn et al., 1996). It was further found that dairy cows milked 3 times daily tend to be lighter in weight compared to those which are milked twice a day. They further noticed that dry matter intake decreases by 15% on 2 times/day milking compared to 3 times milking/day. Further it was reported that dairy cows milked 3 times per day have higher dry matter requirement compared to 2 times milking daily. However, the higher dry matter requirement can be fulfilled by increasing the feeding frequencies (Senn et al., 1996).

Few other researchers showed that milking 3 times daily reduces overall body weight gain in dairy cows. Dairy cows milked thrice a day possess higher tendency of losing body contrast to those who are mile twice per day. Even though, cows are provided *ad-libitum* dry matter, but the dairy cows fail to compensate due to higher energy demand related to increased milk yield. Increasing frequency of feeding, results preferential nutrients utilization for production of milk as well as higher tissue catabolism rate (Peel and Fronk, 1983). Some other researchers suggested higher milk production on higher feed intake which actually serves as long term tissues reserves for nutrients need during milk production. Lactation length also has significant ($P < 0.001$) influence on dry matter intake. Dry matter increases on every next day of lactation by 3.73g (Mengistu et al., 2012). These research outcomes were supported by few other scientists who revealed that lactation onset results dramatic increase in the nutrients requirements of dairy cows such as amino acids, glucose and fatty acids etc. The increased nutrients need is fulfilled by increased voluntary feed intake as well as by an array of metabolic strategies (Burgos et al., 2001). As per few other researchers, GIT hypertrophy, higher fatty acid metabolism in adipose tissues and higher gluconeogenesis rate, are the key changes which possess great importance for maintaining the higher milk yield. When dairy cow efficiently utilize the feed then drastic increase in production occurs. It is also noteworthy, that feed utilization by dairy cows is attributed to quality of offered feed, animal breed and overall physiological status of animal. These findings were supported by results of few other researchers who found that milk yield significantly depends on feed efficiency, environmental contributing factors and genetic capacity of the dairy cow (Royle et al., 1992).

Moreover, few others scientists noted that carbohydrate utilization efficiency can be improved by such treatment strategies which encourage the production of propionate by dairy cows instead of acetate or butyrate production. If the dairy cow is producing higher concentration of propionate, that will be useful for higher feed efficiency. For instance, the elephant grass provided to dairy cows in chopped form increases the surface area of the roughage, thus digestion is improved and as a result production is increased (Salama et al., 2003). According to some other researchers, the hormones such as growth hormone, insulin and prolactin, contribute in controlling the partitioning of energy to milk as well as body tissues. This interaction is related to genetic variations among animals (Stockdale et al., 1997). In another study it was revealed that the higher the milking frequency results higher feeding efficiency, higher feeding frequency and higher milk production. Dairy on 3 times milking utilize feed more efficiently than 2 times and 1 time milking. These results are further supported by King and Stockdale (2014) who stated that dairy cows milked 3 times per day daily have

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feeding efficiency by 14% higher compared to cows milked twice per day. Therefore, dairy cows on 3 times milking frequency have improved performance, if fed as per yield (King and Stockdale, 2014).

CONCLUSION

Present review concludes that the dietary manipulation and milking frequency always play a key role for improving the performance and production of dairy cows. In addition, a high quality feed plus *ad-libitum* water and also increased milking frequency support a good production of dairy cows.

DECLARATIONS

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Author's contribution
Both authors have contributed equivalent effort for this manuscript.

Competing interests
The author has not declared any conflict of interests.

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