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Milk quality in the contest of the dairy cow in family system producers

Calidad de la leche en los concursos de la vaca lechera en el sistema de producción familiar

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ABSTRACT

Dairy cow contests recognize the best cow based on the amount of milk produced, however: quality is also considered in the market. In order to contribute to recognizing the best cow in the dairy family, this study was aimed to determine the physicochemical composition and the somatic cells count (SCC) in the milk of the cows participating in the “The Dairy Cow” contest from Maravatío, Michoacán, Mexico. The main physicochemical components (fat, protein and non-fat solids) and the SCC in milk were determined. Results showed that the winning cow obtained an average production of 39±1.05 liters/day. However, the milk did not have the best components nor the lowest SCC. The best cow regarding the physicochemical components obtained an average of 29.5±1.05 liters/day of milk, with 3.07% protein, 8.35% solids non-fat and 3.26% fat. The cow with the lowest SCC (34,500 SC/ml) was the one with the lowest production. It was shown that the best physicochemical and SCC characteristics in the contest cows do not concentrate on a single animal. In addition, it is important to say that the best cow, apart from being the one with the highest production, should meet the minimum quality requirements according to the context.

Keywords: best cow, family dairy, fat, milk quality, protein.

RESUMEN

Los concursos de la vaca lechera reconocen a la mejor vaca con base a la cantidad de leche producida, aunque, en el mercado también se considera la calidad. Con el fin de contribuir a reconocer a la mejor vaca lechera en la lechería familiar, el estudio tuvo como objetivo determinar la composición fisicoquímica y la cantidad de células somáticas (CCS) de la leche de las vacas participantes en el concurso de “La Vaca Lechera” de Maravatío, Michoacán, México. Se determinaron los principales componentes fisicoquímicos (grasa, proteína y solidos no grasos) y la CCS en la leche. Los resultados mostraron que la vaca ganadora obtuvo una producción promedio de 39±1.05 litros/día, sin embargo, no tuvo los mejores componentes y ni la menor CCS. La mejor vaca respecto a los componentes fisicoquímicos obtuvo en promedio 29.5±1.05 litros/día de leche, con 3.07% de proteína, 8.35% de SNF y 3.26% de grasa. La vaca que obtuvo menor CCS (34,500 CS/ml) fue la de menor producción. Se evidenció que las mejores características fisicoquímicas y de CCS en las vacas del concurso no se concentran en un solo animal; es importante que la mejor vaca, además de ser la de mayor producción debería cumplir con los mínimos requerimientos de calidad que el contexto indique.

Palabras clave: calidad de leche, grasa, lechería familiar, mejor vaca y proteína.

INTRODUCTION

Dairy cow competitions are conducted by governmental or non-governmental institutions, be they local, state or national; which allows boosting and strengthening milk production in the region; in addition to creating interest in dairy production among ranchers and in the public that attends. Ranchers are to these events invited; regularly the largest and most specialized in a forum, expo or fair; where they present their best animals to compete for a short period (regularly for a week). Cows are milked there to measure their production, and the owner of the cow with the highest average milk produced during that period is awarded a monetary award. In this way, the aim is to increase the interest of the rancher or producer for the breeding of animals with better genetics and, therefore, to increase their productive parameters.

Producer participation in these events also represents a great marketing tool. The exhibition of animals at events allows their name, family, their establishment and their animals to be admired, seen and recognized by others. It is a space where producers converge and where they can establish commercial relationships for the sale of animals or other products. This is better if any of their cows is the one with the highest production and is credited to the main positions of the contest, which gives them more admiration and prestige within the guild and in the region, further improving the possibilities of commercialization. These events are a good channel to market some of their copies at different prices.

Despite the above, there are no reports about the promotion of these contests for systems of family milk production in Mexico. This happens because these types of producers are considered unproductive, with cows of poor genetic quality and with very low production; the reports in this regard show production averages that oscillate around 12 liters per cow per day (Camacho-Vera *et al.,* 2017; Chávez *et al.,* 2018; Espinosa *et al.,* 2011; Jiménez-Jiménez *et al.,* 2011). For this reason, the family dairy must adopt what is developed in other specialized forms of milk production and acquire the genetics that develop under other parameters and contexts.

As mentioned, in these events the best dairy cow is awarded based on the amount of milk produced; however, the best cow on the market or in the milk business is not necessarily the one that produces the most milk. For many ranchers the best cows are those that give one calf a year, that is healthy, that can produce most of its life and sustain production during its production cycle. In addition, they seek that the milk contains a minimum of physicochemical and hygienic components that cover their requirements for the elaboration of their products, such as cheese, cream, yogurt, among others.

The total solids in milk and in particular the protein and fat content, are of the main components that in the last decades the dairy industry has put interest to maintain and increase its performance and economic gains. For this, the primary producer has been pressured and required to cover a minimum quantity through the regularization and regulation of global technical standards that have been disseminated in different nations. According to reports from the University of Pennsylvania, if milk has higher amounts of fat and protein, the value of milk increases by ninety cents for every 100 pounds of milk weight (Heinrichs *et al.,* 2016). Also; a decrease of 0.5 percentage units of total solids, may imply a loss of five tons for every million liters of processed milk (Calderón *et al.,* 2006); hence the importance of having cows that can give a good volume of milk with the highest amount of solids.

In the same way, another of the elements that the industry currently considers to qualify the milk of the producers is the Count of Somatic Cells (SCC). The content of these cells helps to know the state of health of the mammary gland, in lactation or the presence of mastitis; the latter, due to its relationship with the components of milk, is an indicator of "milk quality". Due to the inflammatory response during mastitis, a release of blood substances into milk occurs within the animal. Some of which are enzymes that cause protein and milk fat breakdown; the most important are lipase and plasmin, the former breaks down fat, produces a rancid taste and reduces the shelf life of milk; while plasmin will degrade casein and reduce the cheese yield of milk (Hernández and Bedolla, 2008). In this sense, the SCC is an important indicator for the industry, because it indicates that the more SCC, the animal will present a lesser amount of solids in the milk.

Evaluating or rating these components of milk is not a practice that is promoted in contests in Mexico. Most of the calls for these competitions indicate as the only evaluation the volume of milk produced; no attention is paid to milk solids, much less the SCC, since both aspects are also important to promote and have a better commercialization; not only between producers, but also with dairy manufacturers. There are few places where the components of the milk from the best dairy cows are promoted and recognized, and reports in this regard are given through the press; For example, in Nicaragua, the winning cow was not the one that produced the most milk, but the one that had a higher fat content with less volume (López, 2017). In one region of Uruguay, it is mentioned that the best cow of the Holando breed obtained 48.4 liters of milk per day, where it had 3.97% fat and 3.09% protein (Samuelle, 2015). In this same country, the contest winners point out that it is not only about the amount of milk, it is also necessary that the milk of the cows have 4% fat and 3.5% protein, because in the end, in the amount of solids it is where you see the fruit of investing and caring for animals (Samuelle, 2019).

On the research side, studies that focus on showing the physicochemical characteristics and the amount of CS in competition cows are almost nil. In a study carried out in the Dairy Cow contest of Expointer 2007 in Brazil, they found that the champion cow obtained a production of 81.62 kg of milk per day, with a fat percentage of 2.23%, protein of 2.63% and obtained 35,000 CS/ml. The cow that obtained better components was the one that obtained the second place with a production of 76.78 kg of milk, with 2.58% fat and 3.23% protein, but with 285,000 CS/ml (Pinto *et al.,* 2008). It should be noted that the authors conclude that, in general, the cows in the competition presented high milk productions associated with good quality milk. With these references, it is indicated that the cow with the highest production is not necessarily the one with the best components. That is why; another factor that would have to be evaluated in the "Milk Cow" contests in Mexico is the physicochemical quality of the milk and the SCC.

In this sense, in order to provide more elements that help to recognize the best dairy cow in a region and particularly in family dairy, the present study aimed to determine the physicochemical composition and the Number of Somatic Cells. All this in the cows that participated in the contest "La Vaca Lechera" of the expo-fair 2019, from the municipality of Maravatío, Michoacán.

MATERIAL AND METHOS

Maravatío municipality, Michoacán is located in the Northeast of the state, at coordinates 19º54 'of North Latitude and 100º 27' of West Longitude, at a height of 2,020 meters above sea level. It limits to the North with the states of Guanajuato and Epitacio Huerta, to the East with Contepec and Tlalpujahua, to the South with Senguio, Irimbo and Hidalgo, and to the West with Zinapécuaro (INAFED, 2010). Its climate is temperate, with temperatures that oscillate between 14.1 and 29.9 ºC, and rains in summer with an annual pluvial precipitation of 897.7 millimeters. Maravatío has desirable conditions for the development of cattle, specialized in milk production (Ávila, 2014).

The dairy activity is carried out throughout the municipality, but particularly in the towns of the Maravatío Valley, such as Campo Hermoso, Pomas Dolores, Santa Elena, La Colonia, El tejero and Casa Blanca (Chávez *et al.*, 2018; Jiménez-Jiménez *et al.,* 2011). The type of production that predominates in the municipality is family type, 80% of the inventory of dairy cattle are developed in this type of units, which are characterized by being managed by the family, with five members regularly; with herds made up of 2 to 20 cows, which have 1 to 12 cows in production. The cattle are mainly of the Holstein phenotype (to a lesser extent Jersey, Swiss Brown and their crosses), and the average yields per cow per herd range from 9 liters. The marketing of milk is carried out mainly with the cheese manufacturers of the municipality (Jiménez *et al.,* 2014). In such a way that the dairy cow

contest represents a good opportunity for producers to interact and revive this traditional activity of the municipality.

The contest was held within the framework of the Expo-fair of Maravatío 2019, an event commemorating the anniversary of the foundation of Maravatío, Michoacán. The contest was held from April 22 to 27 and was organized by the municipal government to encourage and boost dairy activity in the region. In this event, 4 cows from the communities of Dolores and Campo Hermoso, 2 cows with the Holstein phenotype and 2 from the Holstein x Montbéliarde cross, with an age ranging from 2 to 4 years, participated. The cows were at La Expo from April 20, so they could acclimatize to the environment a few days before the contest began. The cows during the contest were milked twice a day; the first milking was done between 7 and 8 a.m. and the second between 8 and 9 p.m. with a total of 12 milkings during the contest. Milk was measured in liters at each milking, each day recorded on a blanket visible to the public.

To know the physicochemical and SCC characteristics, at the end of each milking (morning and afternoon), a homogenized sample of 60 ml of milk from each cow was obtained, thus obtaining 12 samples per cow. The SCC was performed through the DeLaval Cell Counter (DCC), this is a portable device that runs on batteries and has an optical somatic cell milk meter; use cassettes, which suck small amounts of milk. Once inside the cassette, the milk is with reagents mixed that reach the nucleus of the somatic cells, which allows its count, using a fluorescence sensor (Bedolla *et al.*, 2007).

For the physicochemical components of milk, the MILKOSCOPE Julie C5 portable equipment was used, which by means of ultrasound and infrared spectrum techniques, has the ability to determine different components of milk (fat, protein, lactose, non-fat solids, solids totals, added water) (Scope Electric, 2007). Due to their precision and speed in the determination of the components, as well as the little preparation that the sample requires, this type of instrument is one of the test methods that is increasingly used in companies and in field work.

The information obtained from each sample was captured in a Microsoft Excel database. For the analysis of the information, descriptive statistics were used, where the data of SCC and percentage of fat, protein and non-fat solids (SNF) are presented.

RESULTS AND DISCUSSION

Table 1 shows the milk production obtained by the four cows. The winning cow was the one that was four years old and with the Holstein-Montbéliarde phenotype, obtained a total of 234 liters of milk during the competition and with an average daily production of 39 liters of milk, surpassing the rest by more than 10 liters.

Table 1. Production of milk obtained from participating cows during the "dairy cow" contest, Expo-Fair Maravatío, 2019

Cow	Total	Average
1	234	39 ± 1.095
2	177	29.5 ± 1.049
3	177	29.5 ± 2.81
4	161	26.8 ± 1.169

Regarding the physicochemical characteristics, in table 2, it can be seen that the cow with the highest average percentage of fat was the winning cow with 3.57%, but the one with the highest average percentage of protein and SNF was cow 3, with 3.07% and 8.35%, respectively. This cow obtained the second place with a production in the contest of 177 liters and 29.5 liters of milk on average per day.

Table 2. Average concentration of fat, protein, SNF and CS of the milk of the cows participating in the dairy cow contest, Expo-Fair Maravatío 2019

Cow	% Fat	% Protein	% SNF	SCC/ml
1	3.57 ± 0.66	2.87 ± 0.17	7.88 ± 0.71	87,333 ± 3,4074
2	3.27 ± 0.20	2.99 ± 0.04	8.16 ± 0.17	1,438,500 ± 21,3160
3	3.26 ± 0.18	3.07 ± 0.03	8.35 ± 0.15	1,006,667 ± 12,7761
4	3.34 ± 0.44	2.84 ± 0.07	7.81 ± 0.22	34,500 ± 5,244
Average	3.36 ± 0.41	2.94 ± 0.13	8.05 ± 0.43	641,750 ± 624,826
Class 1 or A*	≥ 3.1	≥ 3.0	mínimo 8%	≤ 400,000

* NMX-F-COFOCALEC-2012, (COFOCALEC, 2014)

In the somatic cell count, the cow with the lowest count was the cow that obtained the third place with 34,500 CS / ml; the winning cow followed with 87,000 CS / ml, and the remaining two cows exceeded one million somatic cells per milliliter.

The results showed that the best dairy cow in the contest was not necessarily the one with the best milk components and the fewest somatic cells. The winning cow only surpassed the rest in fat percentage and obtained third place in protein percentage. In the dairy cow competitions that show some results in this regard, they report something similar, Pinto *et al.*, (2008), in their study found that the cow with the best fat and protein components was the second place with 2.78 % fat and 3.23% protein. This situation is usually a common characteristic; it is known that when more milk is produced, the components decrease due to having a higher dilution factor (Ávila *et al.,* 2014; Calderón *et al.,* 2006; Gellrich *et al.,* 2014). However, according to this, it would be expected that the cows with lower production obtained better components; situation that in both cases does not happen,

both in the reports of Pinto *et al.,* (2008) and in Maravatío; the last places did not have the greatest number of components.

This can be explained by the phenotypic characteristics of the cows that competed. It is known that various breeds of cattle have different capacities to produce more or less physicochemical components in milk. In this regard, the reported phenotypes of the competition cows only involved the Holstein breed and its cross with Montbéliarde. From this last breed, protein and fat averages higher than the Holstein average are reported (Koç, 2011; Saha *et al.,* 2018). In Holstein breeds, 3.6 to 3.7% in fat and 3.27 to 3.3% in protein are reported (Ávila *et al*., 2014); while in the Montbéliarde breed they range between 3.5% in fat and 3.9% in protein (Maciuc *et al.,* 2010; Montbeliarde UK, 2015), and this is similar with the Holstein x Montbéliarde crosses (Malchiodi *et al.,* 2011; Saha *et al.,* 2018).

In the competition, the cows with the highest fat and protein components were the cows with the Holstein x Montbéliarde phenotype, that is, cow 1 and 3. It is possible that the amount of milk components in the competition could have been more influenced by genetic precursors of the animals, that only the dilution factor that produces more milk.

Concerning the SCC, the winning cow of the contest had the second lowest Amount of Somatic Cells. Something similar reported by Pinto *et al.,* (2008) of the cows participating in Expointer 2007, the cow with the highest production also did not obtain the lowest SCC. It is recognized that CS are an indicator of the presence of mastitis, in such a way that as SCC increases there is a greater predisposition for mastitis, which influences the amount of milk produced (Olsson, 2017), In addition, it causes alterations in the physicochemical components of milk and the shelf life of milk derivatives (Calderón *et al.,* 2006; Heinrichs *et al*., 2016).

Somatic cell counts greater than 500,000 cells/ml indicate that one third of the glands are infected and that milk loss due to subclinical mastitis is greater than 10% (Hernández and Bedolla, 2008). In this regard, cows 2 and 3 of the contest presented counts above one million CS/ml, it is very likely that, due to the change in environment (noise, feeding, handling, among others), due to stress, they have presented subclinical mastitis, since that as the days passed, the SCC was decreasing. It is possible that the milk due to the stress in the changes in the cow's environment and due to mastitis provokes alterations in the physicochemical characteristics, as reported (Gellrich *et al.,* 2014).

It should be noted that the cow that obtained the least amount of SC was not the one with the highest milk production; on the contrary, it was the one that obtained the least production, and by the SCC indicates that it was not due to a mastitis problem, but to its low genetic production capacity. Low SCC is recognized to be associated with the breed genotype of cows. In some studies, it has been observed that the Montbéliarde breed presents less SCC (Koç, 2011; Malchiodi *et al.,* 2011), a characteristic that gives it the

anatomical strength of its udders. In the contest, only two cows had this phenotype, one of them was the winning cow that obtained less than 100,000 CS/ml, and the other was cow 3, which obtained more than 1 million CS/ml. This difference may indicate that there are different factors that can affect the SCC and that it does not only depend on race.

It is notorious that the physicochemical characteristics of the milk and the somatic cell count of the competition cows are not concentrated in a single animal, so evaluating the best cow under these precepts does not seem practical. It is not always the cow with the highest protein and fat concentrations produces the most milk or the one with the lowest SCC. A single indicator cannot be the one that determines which cow is the best, in a context where several aspects must be considered to represent the prestige of a producer in his guild and in the dairy market. Perhaps the best dairy cow should be one that, in addition to being the highest milk producer, should meet the minimum requirements that the context indicates, as observed in the study by Pinto *et al.,* (2008), meet the indicators that the local actors agree and the norms or standards that are indicated in the country.

In México there is a standard NMX-F-COFOCALEC-2012 which grants the physiochemical and sanitary specifications of row cow´s milk. This standard classifies by components and for SCC in different classes, being class 1 or A, the best, for the fat represent values ≥ 3.1%, protein ≥ 3%, lactose between 4.1 y 4.85%, SNF minimum 8%, and for SCC/ml ≤ 400,000 (COFOCALEC, 2014). In this regard, the cows that came closest to found this standards were the cow 1 for % of fat and SCC for protein classes and did not reach the minimum for SNF and cow 3 achieved class 3 for protein and fat, with minimal SNF and got class 4 for SCC. Although none reaches the best standards according to the norm, it will be observed that cow 3 reached more standards, in addition, to having more milk than 2 and 4, so according to the production and components it could be considered as the best among the contestants.

In this study, it was not possible to find the cow that had all the requirements, both in quantity and in quality of milk. As the standards are suggested, the number of cows that participate in the contest may be a limitation in order to identify the cow that can be high producer and fulfill with country´s quality standards and despite the fact that the municipality has a tradition of milk production; producers are not encouraged to participate in these contests.

It is notable that in the milk´s cow of the contest there is a heterogeneity i its volume, components and health, which is undoubtedly a reflection of the same diversity that characterizes the small-scale familiar production system, where the productive characteristics are a reflection of the geographical and socioeconomic context in which these systems prevail. Despite, the physicochemical characteristics, the SCC and the volume found in the cows of this contest show that in production familiar systems could have good yields in volume and quality. It is important that they promote public policies in

support of this type of systems since they can provide a raw material a good quality food that covers milk deficiency in the country.

CONCLUSIONS

In order for a cow to be the best at the local, regional or national level considered and according to the needs of the dairy market, it should consider both milk production and the physicochemical characteristics and the Count of Somatic Cells in milk. The cow that produces more milk cannot be the best, if it does not meet at least the standards indicated in each region or country. For this reason, if you want to promote and strengthen dairy activity in a region, it would be advisable to include in the dairy cow competitions the evaluation of the main components of milk, as well as the count of Somatic Cells. Since they are indicators that they are becoming increasingly relevant in the dairy market, and the market for small producers is no exception.

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