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PHYSICOCHEMICAL PROFILE OF REFRIGERATED RAW MILK OBTAINED FROM COMMUNITY TANKS IN RURAL LOCATIONS IN THE MUNICIPALITY OF XINGUARA, PARÁ

PERFIL FÍSICO-QUÍMICO DO LEITE CRU REFRIGERADO OBTIDO EM TANQUES COMUNITÁRIOS DE LOCALIDADES RURAIS NO MUNICÍPIO DE XINGUARA, NO PARÁ

PERFIL FÍSICO-QUÍMICO DE LA LECHE CRUDA REFRIGERADA OBTENIDA EN TANQUES COMUNITARIOS DE UBICACIONES RURALES

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ABSTRACT

The objective was to evaluate some physical-chemical characteristics of refrigerated raw milk obtained in community tanks in rural locations in the municipality of Xinguara-PA. 192 samples were collected from community tanks in eight different locations during the period from July to September 2021 and sent to the Food Laboratory of the University of the State of Pará, and subsequently submitted to physical-chemical analyzes of pH, acidity (ºD), fat, total dry extract (EST), defatted dry extract (ESD), density and cryoscopic index (ºH), all made in duplicates. The results were compared to the quality standards established by normative instruction 76/2018 (Brasil, 2018a). The physical-chemical evaluations showed satisfactory results for most parameters. However, milk samples showed outside the standards of the legislation for density determinations of the 3C,4D,5E,7G, and 8H locations, and cryoscopic index of the 4D and 8H locations, respectively, 50% and 58.33% of the samples below -0.530ºH, indicating fraud by adding water. It is concluded that the raw milk stored in community tanks studied in eight locations in the region of the municipality of Xinguara- Pará met the standards compared to In 76, except for some samples referring to the density parameters and cryoscopic index. Thus, monitoring studies of the physical-chemical composition is essential to identify possible interferences in the production of milk quality.

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Keywords: Community Tanks. Quality of Refrigerated Raw Milk. Physicochemical Evaluation. In 76.

RESUMO
Objetivou-se avaliar algumas características físico-químicas do leite cru refrigerado obtido em tanques comunitários de localidades rurais no município de Xinguara- PA. Foram coletadas 192 amostras de tanques comunitários em oito localidades diferentes durante o período de julho a setembro de 2021, e encaminhadas para o laboratório de Alimentos da Universidade do estado do Pará, e posteriormente submetidas as análises físico-químicas de pH, acidez (ºD), gordura, extrato seco total (EST), extrato seco desengordurado (ESD), densidade e índice crioscópico (ºH), feitas todas em duplicatas. Os resultados foram comparados aos padrões de qualidade estabelecidos pela instrução normativa 76/2018 (Brasil, 2018a). As avaliações físico-químicas apresentaram resultados satisfatórios para a maioria dos parâmetros. No entanto, amostras de leite evidenciaram fora dos padrões da legislação para as determinações de densidade das localidades 3C,4D,5E,7G,8H e indicie crioscópico da localidade 4D e 8H, respectivamente, 50% e 58,33% das amostras abaixo de - 0,530ºH, indicando a fraude por adição de água. Conclui-se que o leite cru armazenado em tanques comunitários estudadas de oito localidades na região do município de Xinguara-Pará, atenderam os padrões em comparação com a In 76, exceto algumas amostras referentes aos parâmetros de densidade e indicie crioscópico. Com isso, estudos de acompanhamento da composição físico-química é fundamental para identificar as possíveis interferências na produção da qualidade do leite.

Palavras-chave: Tanques Comunitários. Qualidade do Leite Cru Refrigerado. Avaliação Físico-química. In 76.

RESUMEN
El objetivo fue evaluar algunas características físico-químicas de la leche cruda refrigerada obtenida en tanques comunitarios en localidades rurales del municipio de Xinguara-PA. Se recolectaron 192 muestras de tanques comunitarios en ocho lugares diferentes durante el período de julio a septiembre de 2021, y se enviaron al Laboratorio de Alimentos de la Universidad del Estado de Pará, y posteriormente se sometieron a análisis físico-químicos de pH, acidez (ºD) , grasa, extracto seco total (EST), extracto seco desgrasado (ESD), densidad e índice crioscópico (ºH), todos realizados por duplicado. Los resultados fueron comparados con los estándares de calidad establecidos por la instrucción normativa 76/2018 (Brasil, 2018a). Las evaluaciones físico-químicas mostraron resultados satisfactorios para la mayoría de los parámetros. Sin embargo, las muestras de leche mostraron fuera de los estándares de la legislación para las determinaciones de densidad de las ubicaciones 3C, 4D, 5E, 7G, 8H y el índice crioscópico de la ubicación 4D y 8H, respectivamente, el 50% y el 58,33% de las muestras por debajo de - 0,530ºH , indicando fraude al agregar agua. Se concluye que la leche cruda almacenada en tanques comunitarios estudiados en ocho localidades de la región del municipio de Xinguara-Pará cumplió con los estándares en comparación con En 76, excepto algunas muestras referentes a los parámetros de densidad e índice crioscópico. Por lo tanto, los estudios de seguimiento de la composición físico-química son esenciales para identificar posibles interferencias en la producción de leche de calidad.

Palabras clave: Tanques Comunitarios. Calidad de la Leche Cruda Refrigerada. Evaluación Fisicoquímica. En 76.

1 INTRODUCTION

Brazil is the world's fifth largest milk producer (Nespolo et al., 2017). The production chain extends from north to south, in 2019 the production was approximately 34.0 billion liters, the second highest volume ever recorded in the country. Among the states, Pará has been showing an increase in production, with more than 605 million liters of milk, being the second largest producer in the northern region, and about 70% of production is concentrated in the southeastern mesoregion of Pará (IBGE, 2019).

Milk is rich in nutrients and one of the most consumed foods by most of the world's population, especially in childhood and in the stages of old age. It is basically composed of water in its composition, in addition to vitamins, minerals, proteins, fats and carbohydrates that together form the solid content (Elias et al., 2014). In addition, milk is also used as a raw material for industry in the production of UHT milk, cheese, butter, yogurt and other dairy products, which depends on the quality of its composition (Carvalho et al., 2015).

However, this milk composition may present a low quality due to the consequences of variable factors, such as: the influence of the seasons, production and handling practices at the farm level, geographic location, deficiency in milking management and hygiene; both manual and mechanical; high rates of mastitis in animals; inadequate maintenance and disinfection of equipment and utensils; inefficient cooling or inexperience and unskilled labor (Leira et al., 2018; Zeni et al., 2013).

In view of this, the milk must undergo strict quality control, it is of great importance to carry out physical-chemical and microbiological analyses, characteristics that are considered safe for human consumption and for the preparation of dairy products. And it must meet the quality standards determined by law and be free of foreign substances, adulterants, and preservatives (Santos et al., 2021).

In Brazil, Normative Instruction No. 76 (In 76) of November 26, 2018 of the Ministry of Agriculture, Livestock and Supply (MAPA) is the current legislation that deals with the physical-chemical and microbiological parameters of refrigerated raw milk (Brasil, 2018a). The legislation allows producers to share community tanks for the preservation of milk.

Community expansion tanks are used in associations formed by producers, making it possible to cool the milk in a single tank, which is installed at a fixed point on one of the properties and receives milk from the others. Thus, producers who are unable to acquire and/or maintain a refrigeration tank are able to remain in the activity to comply with legal determinations. However, the milk stored in these tanks comes from different producers and is susceptible to factors related to the production system, which can interfere with its composition (Souza et al., 2009; Souza et al., 2011). Through physicochemical examinations

it is possible to evaluate any non-conformities of the milk, and possible adulteration of its composition (Sobreira et al., 2022).

There is little information on the quality of milk stored in tanks for collective use in rural locations in the municipality of Xinguara-PA. Thus, considering the importance of milk quality control, this study aimed to evaluate some physicochemical characteristics of refrigerated raw milk obtained from community tanks compared to the vestments established by IN 76/2018.

2 METHODOLOGY

2.1 ABOUT THE STUDY, MILK SAMPLES AND PHYSICOCHEMICAL ANALYSES

The study was carried out in eight rural locations in the municipality of Xinguara, which is located in the southeastern mesoregion of the state of Pará. A total of 192 samples of refrigerated raw milk were collected during the months of July to September 2021, directly in the community tanks of the localities of Duas vendas, Igrejinha, Posto 70, Rio vermelho, São Francisco, Terra Roxa, Vila União and Xinguara.

The milk samples were deposited in polyethylene plastic bottles (clean and sanitized), packed in Styrofoam boxes containing ice and kept cooled at a temperature (between 4 and 6 °C), until they were sent to the Food Laboratory of the State University of Pará – Campus XV, which is located in the municipality of Redenção, Pará, Brazil. and subsequently, physicochemical analyses were submitted, all done in duplicates.

The Master mini ultrasonic milk analyzer (Akso) was used, previously calibrated and quantified for Fat, Defatted Dry Extract (ESD), Density and Cryoscopic Index. The pH determination was verified in the INSTRUTHERM brand meter, model pH 2600, calibrated with known solution; The titratable acidity (in Dornic degrees ºD) was determined by titration with sodium hydroxide (NaOH) 0.1 N, and in the presence of the Phenolphthalein indicator; The concentration of the Total Dry Extract (TSE) was verified, for these analyses, the instructions of the Manual of Official Methods for the Analysis of Foods of Animal Origin (Brasil, 2018b) were followed.

The results of the physicochemical analyses were tabulated in average values referring to the collections from July to September, while individual milk samples that were within and outside the physicochemical standards were described in percentage terms and compared with the legal requirements for refrigerated raw milk established by In 76 (Brasil, 2018a).

3 RESULTS AND DISCUSSION

The mean results of the physicochemical parameters of milk samples evaluated from community expansion tanks are shown in table 1.

Table 1

Mean values and standard deviations of the physicochemical analyses of 192 samples of refrigerated raw milk from the eight rural locations studied in the municipality of Xinguara-PA, from July to September 2021

Locations	ph	Acidity (ºD) **	Fat (g/100g)	EST (g/100g)	ESD (g/100g)	Density at 15 Cº (g/L)	Cryoscopy *** (ºH)
*	Mean and Standard Deviation						
1 A	6.74 ± 0.04	16.27 ± 0.49	3.28 ± 0.31	11.92 ± 0.38	8.63 ± 0.11	1.028 ± 0.01	-0.532 ± 3.03
2 B	6.74 ± 0.04	16.08 ± 0.52	3.38 ± 0.04	11.93 ± 0.41	8.67 ± 0.08	1.032 ± 0.01	-0.532 ± 3.37
3 C	6.72 ± 0.10	16.31 ± 0.38	3.36 ± 0.04	11.94 ± 0.46	8.72 ± 0.08	1.041 ± 0.01	-0.535 ± 2.37
4 D	6.77 ± 0.03	16.05 ± 0.29	3.37 ± 0.05	12.39 ± 0.41	9.14 ± 0.87	1.026 ± 0.38	-0.528 ± 2.86
5 E	6.73 ± 0.04	17.00 ± 0.81	3.38 ± 0.06	12.11 ± 0.11	8.71 ± 0.10	1,040 ± 0,01	-0.535 ± 4.10
6 F	6.73 ± 0.05	16.43 ± 0.93	3.38 ± 0.05	11.89 ± 0.48	8.65 ± 0.11	1.031 ± 0.01	-0.532 ± 4.76
7 G	6.71 ± 0.05	16.77 ± 0.95	3.36 ± 0.04	12.12 ± 0.06	8.76 ± 0.05	1,039 ± 0,01	-0.537 ± 6.18
8 H	6.67 ± 0.05	17.10 ± 0.69	3.37 ± 0.06	11.93 ± 0.16	8.56 ± 0.13	1.014 ± 0.01	-0.527 ± 5.31

* 1A = Two sales; 2 B = Igrejinha; 3 C = Posto 70; 4 D = Rio Vermelho; 5 E = São Francisco; 6 F = Terra Roxa; 7 G = Vila União; 8 H = Xinguara. ** Dornic Grades (ºD); EST: Total Dry Extract; ESD: Defatted Dry Extract; Hortvet degrees (ºH). Source: Authors (2022).

For the pH of milk from a healthy cow that has recently been milked, Santos and Fonseca (2007) cite the range between 6.6 and 6.8 as being normal pH. The mean pH values found in the present study ranged from 6.67 to 6.77 (Table 1). The pH assessment of milk can be an indicator of initial quality and thermal stability of milk (Melo et al., 2018). According to Oliveira et al., (2010) in severe cases of mastitis in the animal, the pH can reach 7.5 and, in the presence of colostrum, it can drop to 6.0.

Regarding the average results of milk acidity obtained in Dornic degrees (ºD) (Table 1), 100% of the samples (192/192) from the eight locations evaluated were within the limit of 14 to 18 ºD with what is recommended by In 76 (Brasil, 2018a). This result indicates that the acidity of the milk is in adequate conditions to undergo processing or be processed.

In studies conducted by Bastos et al., (2018) analyzing the quality of refrigerated milk from 29 community tanks of producers in the South of Espírito Santo, where, of the 87 samples analyzed for titratable acidity, only 2 samples (2.3%) were outside the recommended by IN 62/MAPA. Ulisses et al., (2022) found titratable acidity values in Dornic degrees (ºD)

ranging from 12 to 20 ºD in refrigerated milk samples collected from individual and collective tanks of rural properties in the municipality of Alegre - ES.

Arbello et al., (2021) explains that acidity results above 18 Dº indicate bacterial proliferation, in which these agents transform the lactose in the milk and produce lactic acid. And also, it may indicate that the milk was obtained in inadequate hygienic-sanitary conditions, due to failures in good practices or in the cooling of the milk. However, acidity below 14 Dº is indicative of fraud due to the addition of alkaline substances, aiming to reduce a high acidity caused by the high rate of development of undesirable bacteria (Castanheira, 2010).

However, fat is the component of milk that suffers the greatest variation between factors and can be influenced by the breed of the animal, stage of lactation, feeding, seasons, and especially by nutritional or metabolic factors (Gonzáles & Noro, 2011).

Table 1 shows the results of the milk fat content, whose mean values ranged from 3.28 to 3.38 (g/100g). In this study, 100% of the samples (192/192) analyzed from the localities were above the standard recommended by Brazilian legislation, of at least 3g/100g (Brasil, 2018a).

Comparing the fat content results with the studies of Gonçalves et al., (2020) Samples of refrigerated fresh milk from farms in the region of Mato Grosso do Sul – MS were analyzed, which obtained an average of 3.56 g of fat, and only 92% (23/25) of the samples were within the legality.

Total Dry Extract (EST) corresponds to all the components of milk, except water. For the industry, the most relevant solid components are fat and protein, which directly affect the yield of dairy products, and are of great industrial interest (Antes & Dias, 2014). Therefore, the EST analysis is essential to evaluate the integrity of the milk composition.

When evaluating the total dry extract for refrigerated raw milk, in the present study, the mean values ranged from 11.89 to 12.39 g/100g (Table 1), and all samples (192/192) remained within the established by IN 76/2018 of at least 11.4g/100g (Brasil, 2018a).

However, the results of TSS from other studies corroborate this research. In the analysis of milk from 8 community tanks of properties in the municipality of Aricanduva-MG, Santos et al., (2021) observed mean values of 11.76g; Gonçalves et al., (2020) was 13.33g in Aparecida do Taboado in Mato Grosso do Sul; Gomes et al., (2011) the samples showed averages above 12.0g of EST from different rural properties in the southeastern region of the state of Pará

The Defatted Dry Extract (ESD) of milk is made up of the union of solid elements (basically protein and lactose), minus water and fat (Júnior et al., 2013). An ESD reduction in milk composition also affects industrial yield.

It was verified that the averages of the study period were 8.56 to 9.14g (Table 1) for the Defatted Dry Extract, in which all samples (192/192) remained within the legal requirement of at least 8.4g, a standard established by the current legislation (Brasil, 2018a). Souza et al., (2011) found similar results for ESD from 8.63 to 9.22g, in which all samples were also within the legality.

The determination of the Density allows to verify the occurrence of fraud, that is, values below 1.028 may indicate the addition of water and values above 1.034 due to the addition of other substances (solutes) or the skimming of the milk itself (Santos et al., 2011). The mean values of the different physicochemical evaluations for Density inserted in Table 1 reveal that milk samples from five locations were outside the standard of 1.028 to 1.034 g/mL proposed by In 76/2018 (Brasil, 2018a).

Of the 24 Density determinations made in the samples, during the evaluation period, respectively, nineteen (79.17%) from the 3C location, twenty (83.33%) from the 5E and nineteen (79.17%) from the 7G locality, were higher than the standard. However, the locations of 4D, had twelve samples (50%), and 8H, fourteen (58.33%), being below the minimum established for density and cryoscopic index, thus indicating the criminal practice of fraud by adding water.

Júnior et al., (2013) described 5.40% of the 74 samples of refrigerated raw milk outside the standard for Density collected from the Ivaiporã/PR region. The authors found that two (2.70%) had values higher than 1.034 g/mL, and the other two samples (2.70%) were below 1.028 g/mL, indicating fraud due to the addition of water. And also according to the aforementioned authors, the result of the two samples, which had a density of less than 1.028, also presented a cryoscopic index compatible with the addition of water. In addition, the occurrence of milk fraud due to the addition of water significantly reduces its nutritional value. In addition to harming the microbiological quality of the product, this procedure reflects the lack of commitment to the production of quality milk (Souza et al., 2011).

The cryoscopic index is an assessment of the freezing point of milk, the point accepted by legislation is between -0.530ºH to -0.555ºH (Brasil, 2018a). According to Santos et al., (2011) when water is added to milk, consequently, the freezing point increases towards the freezing point of water (0 °C). This adulteration by the addition of water causes several losses to the milk industry, as it determines lower production yield, loss of product quality and increase in production costs (Silva et al., 2016).

In the cryoscopy result (Table 1), the mean values ranged from -0.527 to -0.537ºH, and the 4D locations were twelve (50%) and fourteen (58.33%) 8H from the milk samples that were below the standard established by In 76, evidencing the addition of water. Firmino et al., (2010) evaluated the physicochemical quality of refrigerated raw milk in twenty expansion tanks of producers in the region of Rio Pomba, Minas Gerais, submitted 60 samples to cryoscopic index determination and found substandard results in 25 samples (41.67%), concluding the fraud by addition of water.

4 CONCLUSION

It is concluded that the raw milk stored in community tanks studied in eight localities in the region of the municipality of Xinguara-Pará, presented pH, acidity, fat, total dry extract and defatted dry extract within the quality standards accepted by normative instruction 76. However, the density and cryoscopic index parameters of five locations were outside the limits established by the legislation. Thus, follow-up studies of the physicochemical composition are essential to identify possible interferences in the production of milk quality.

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