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# Requeijão Moreno, a product of the Mucuri Valley in Minas Gerais and its socioeconomic importance

## Requeijão Moreno, um produto do Vale do Mucuri em Minas Gerais e sua importância socioeconômica

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## ABSTRACT

Artisanal cheese production in Brazil is a tradition and is on the rise. In Minas Gerais state, the "Queijo Minas Artesanal" is a national historical and cultural intangible heritage, with several recognized regions. The present research sought to characterize the production technique of Requeijão Moreno in the Mucuri Valley. Producer profiling and production flowchart were drawn by applying semi-structured questionnaires to producers while visiting thirteen family farming properties (25% sampling), selected by the Minas Gerais Technical Assistance and Rural Extension Company (EMATER) MG from among the municipalities in the Teófilo Otoni microregion. It was confirmed that the Requeijão Moreno production is a family tradition, produced mostly by couples aged 56 to 70 with incomplete primary education, and primarily natural of the region. The Requeijão Moreno contribution to the familiar income of the visited producers is between 80 and 100%, with variations influenced by typical regional seasonality and other environmental factors. The resulting data revealed that the research area would greatly benefit from local development programs based on territoriality to add value to rural producers, to the Requeijão Moreno as a product, and the *terroir*, while fostering socioeconomic advancements. As a result, the present research may contribute to the recognition of the region, possible regulation of Requeijão Moreno production, and the perpetuation of this traditional delicacy from Mucuri Valley (MG).

**Keywords:** artisanal cheeses; socioeconomic importance; family farming.

## RESUMO

A produção de Queijos Artesanais no Brasil é tradicional e ascendente. No estado de Minas Gerais, o "Queijo Minas Artesanal" é patrimônio imaterial histórico e cultural nacional, com diversas regiões reconhecidas. A presente pesquisa objetivou caracterizar a técnica de produção do Requeijão Moreno no Vale do Mucuri. O perfil dos produtores e o fluxograma de produção foram desenvolvidos por meio da aplicação de questionários semiestruturados aos produtores, em visita às treze propriedades de agricultura familiar (amostragem de 25%), selecionadas pela Empresa de Assistência Técnica e Extensão Rural de Minas Gerais (EMATER MG) entre os municípios da microrregião de Teófilo Otoni. Confirmou-se que o Requeijão Moreno é tradição passada de "pai para filho", produzido em sua maioria por casais com idade entre 56 e 70 anos, tendo ensino fundamental incompleto e residência desde a infância no mesmo local ou região. O Requeijão Moreno contribui de 80 a 100% para a renda familiar dos produtores visitados, com variações influenciadas pela sazonalidade típica dessa região e por outros fatores ambientais. Os dados obtidos revelaram o potencial da região estudada para programas de desenvolvimento local baseado na territorialidade, visando a valorização do produtor rural, do produto Requeijão Moreno e do *terroir,* agregando melhorias socioeconômicas. Como resultado, a presente pesquisa poderá contribuir para o reconhecimento da região, possível regulamentação da produção do Requeijão Moreno e perpetuação dessa tradicional iguaria do Vale do Mucuri (MG).

**Palavras-chave:** queijos artesanais; importância socioeconômica; agricultura familiar.

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## Introduction

Artisanal cheese production involves historical and economic aspects, social interaction, and specific environmental factors based on the region where the production happens. Specific regulations and public policies seeking to preserve and valorize artisanal cheeses are a global trend, with France as the primary reference. In 2010, more than 44 distinct types of French cheese were legally recognized under the protected designation of origin (PDO), a way of preserving tradition and variability and avoiding falsification (Oliveira, 2010). Current data reveals that there are more than 500 varieties (all included, PDO or not), exceeding any other country in the world (Ciência do Leite, 2023).

In times of redefinition of famous gastronomy with the great appreciation of natural and healthy foods, and standing contrary to *fast foods*, artisanal raw milk cheeses without pasteurization encompass popular culture, traditions, and customs, reflecting the identity of peoples, nations, civilizations, ethnic groups, communities, and families (Sant'ana and Muller, 2019). Among the different artisanal cheeses that are traditionally manufactured with unique biodiversity from a specific region are Feta from Greece (Litopoulo- Tzanetaki and Tzanetaki, 2014), Serra da Estrela from Portugal (Lima et al., 2020), Kazak from China (Zheng et al., 2018), Paipa from Colombia (Benavides-Sánchez and Pena-Serna, 2022), among others.

In addition to its cultural and gastronomic richness, cheeses produced with raw milk are a living food, an endogenous product with sensory characteristics, nutritional potential, and extreme relevance to human health (Lima et al., 2020). The natural raw milk bacterial community, apart from adding flavor (Zheng et al., 2018), can help to reduce pathogens during the manufacturing/ripening process of artisanal cheeses, as is the case of *Lactobacillus* spp. (Bonilla-Luque et al., 2023).

In Brazil, there are different production techniques as well as cheese diversity in terms of physical-chemical, microbiological, and sensory characteristics, which are influenced by the culture and climate of each specific region, resulting in microbiomes with identities expressed in unique flavors (Kamimura et al., 2019). In Minas Gerais, the artisanal way of making "queijo-de-minas" is a national cultural heritage registered by the Institute of National Historical and Artistic Heritage of the Ministry of Culture (IPHAN, 2008) and, possibly soon to become an intangible heritage of the United Nations Educational, Scientific and Cultural Organization (UNESCO) (Minas Gerais, 2023).

State Law No. 23,157/2018, regulated by State Decree No. 48,024/2020, defines the production and commercialization of artisanal cheeses, which must adhere to the historical and cultural traditions of their respective regions and states, being always produced from fresh, raw whole milk, sourced and processed on the property of origin, presenting a firm consistency, color, and flavor, uniform mass, free from colorings and preservatives, with or without mechanical made eyes (Minas Gerais, 2018).

Currently, artisanal cheeses generate income for 30 thousand families, with an annual production of 85 thousand tons (Minas Gerais, 2024). There are 15 regions recognized as Artisanal Cheese producers in Minas Gerais (Paiva et al., 2023). Currently, Requeijão Moreno is produced without its characterization or registration of its "way of making", and even without technical regulation of identity and quality (RTIQ), despite being a traditional delicacy.

Considered a typical product of the Jequitinhonha and Mucuri valleys (Sobral et al., 2022), there is variation in its manufacturing among producers, without specific standards that identify it, as it is an artisanal cheese. The lack of registration of its "way of making" and regulation adds a limit to its commercialization and encourages clandestinity, giving space to possible health risks due to non-conformities in its quality (Araújo et al., 2020).

## Theoretical foundation

Within the context of territorial development discussions, in reaction and resistance to the globalization processes experienced in recent decades, the territory is not only based on its physical space but on a field of forces, webs, and networks of social relationships (Rafestin, 1993). These spaces, known as *terroirs*, have the potential to produce unique identities rooted in sustainable sociocultural dynamics, which can be the driving force of competitive strategies, facilitating local development, employment, and income growth, reducing the rural exodus, and avoiding large urban concentrations (Braga et al., 2004).

*Terroir*, a word of French origin, is used in the production of wine, olive oil, coffee, and artisanal cheese, among others. The term entails a territory that, through its attributes, adds value and uniqueness to products from a given region or location (Albagli, 2004). It is a distinct agrosystem endowed with the capability to produce particular products, which gives them originality and unique characteristics (Salette, 1998). This concept involves both certification and supply while favoring the producer, who gains international market recognition, and the consumer, who can expect a quality product manufactured in the traditional method, respecting the environment (Araújo et al., 2020).

Sustainable local development based on territoriality encompasses the interaction of different economic activities and the environment. As a way of local affirmation at the expense of the global, the local development of a territoriality engulfs social, environmental, and cultural components of regions that share similar particularities, creating good conditions for dynamic activities and greater collective competitiveness, which is full of local culture that cannot be copied (Flores, 2004).

Sustainability is the relationship between economic and ecological systems, which aims to perpetuate human existence while maintaining the effects of human activities within the limits of the planet without destroying its diversity, complexity, and functions of the ecological system life support (Corrêa and Passini, 2022).

Sustainable local development programs based on territoriality must consider seven dimensions, according to Sachs (Corrêa and Pas-

sini, 2022), which are also United Nations (UN) references to guide countries, states, and municipalities through the 2030 Agenda for Sustainable Development. The dimensions are social, environmental, ecological, territorial, economic, cultural, national, and international policies (ONU, 2024). Among the objectives, several stand out: maintaining the diversity of fauna and flora; increasing the productivity and income of small food producers while ensuring sustainable production systems; preserving ecosystems; appreciating and preserving cultural and environmental heritage; developing public policies for national and regional planning; and fostering sustainable tourism to generate jobs and promote local cultures and products.

An observation should be made about gastronomic tourism in the family farming context and its essential role in improving rural space, creating closer relations between producers and consumers, and promoting agricultural diversification (Everett and Aitchison, 2008). Local productive systems or local productive arrangements (LPAs) in rural spaces can improve both the supply of agricultural production and opportunities for non-agricultural production, generating income distribution (Flores, 2004). In this sense, future perspectives are promising when it comes to cheeses and other unique ingredients in gastronomy. The market for products qualified as premium (olive oil, cheese, wine, chocolate, coffee, meat, among others) will continue to expand and diversify, both due to continued chefs' appreciation and typical agricultural diversification of family farming (Nascimento et al., 2022).

Family farming is responsible for the best part of the artisanal cheeses in Brazil; in Minas Gerais, the Requeijão Moreno is estimated to have 869.05 tons of annual production (EMATER MG, 2021), being superior in quantity compared to other already recognized artisanal cheeses. In addition to the economic relevance of its production, it is necessary to consider the quality of the product through research about its characterization and sensory particularities (Bemfeito et al., 2016), seeking possible adjustments to sanitary patterns, without losing the traditional "way of making" of the local artisanal cheese producers.

As for the Requeijão Moreno, there is a certain "confusion" regarding its nomenclature, often being called Requeijão do Norte, Requeijão Crioulo, do Nordeste, Baiano, "Requeijão Frito na Manteiga" (Foundation for Biodiversity Online – Slow-Food, 2024) and it is commonly mistaken for the Requeijão de Manteiga. There are no recordings of its origin, producer profile, recipe identification, or production adjustments based on the environment in which they are produced. They are sold in an assortment of formats, most commonly rectangular, with varying colors, without branding, and are generally packaged in plastic bags.

Characterizing artisanal cheese production in a specified region is a way of formalizing the production and improving sanitary and hygiene conditions, which are important to make the product competitive, create jobs, improve the value of family farming, and reduce rural emigration (Vale, 2018).

In this context, the present paper sought to characterize the production of Requeijão Moreno in Mucuri Valley (MG), a territory with similar geographical relief, climate, and vegetation characteristics, and as a result, influencing the microbiota of this *terroir*.

## Materials and methods

The Mucuri Valley is located in the northeast of Minas Gerais, 450 km from Belo Horizonte, composed of 24 municipalities divided into two microregions, to the east, the microregion of Nanuque with nine municipalities, and to the west, the microregion of Teófilo Otoni, consisting of 13 municipalities: Ataléia, Catuji, Frei Gaspar, Itaipé, Ladainha, Novo Oriente de Minas, Ouro Verde de Minas, Pavão, Poté, Teófilo Otoni, Malacacheta, Fransciscópolis, and Setubinha (IBGE, 2021).

The Mucuri Valley's history is marked by the progressive deforestation of the Atlantic Forest. It was initially replaced by coffee plantations in the 1930s, followed by wood extraction and, then, transitioned to livestock farming. Despite the richness of natural resources, the region remained economically underdeveloped, with low rates compared to other regions of Minas Gerais (Achtschin, 2020). According to Moreira and Martins (2017), extreme inequality is a persistent trait in the municipalities of this region.

The valley is named after its main river, Mucuri. The Mucuri River hydrographic basin has a total length of 425 km, including its Bahian stretch, with 320 km spread through 16 municipalities in Minas Gerais. The Jequitinhonha and Mucuri valleys boast geological richness, characterized by predominant latosols in the granitic rocky outcrops, contributing to the scenic beauty seen throughout the region. Additionally, they give rise to shallow soils, specifically the Litholic Neosols with the A horizon (Fernandes, 2013). In the lowlands, gleisol soils are the most common and appear throughout all regions, commonly known as marsh soils. They constitute diffuse spring environments, which are defined as permanent preservation areas (EMATER MG, 2021).

In the Atlantic Forest Biome, the semideciduous seasonal forest predominates with the dominant tree elements being induced to physiological rest and resulting in a percentage of deciduous trees between 20 and 50% of the forest set (IEF, 2022). The climate is humid tropical, with the dry season occurring between July and September (60 to 140 mm), while the rainy season is set between December and March with an average rainfall of 450 to 600 mm (EMATER MG, 2021). This seasonality interferes directly with the milk and consequently the *requeijão* production, in terms of quantity and quality, due to changes in the availability of food for livestock.

The average annual temperature ranges from 22 to 25°C, with maximums between 29 and 31°C and minimums ranging from 17 to 19°C. As for the annual relative humidity, there is slight variation throughout the year, with averages around 75% (EMATER MG, 2021). Altitude is of significant influence on the production of "Queijo Minas Artesanal" (QMA); it is necessary to control temperature and humidity, among

other factors, during the maturation process. In the case of Requeijão Moreno, temperature influences the fermentation process, storage time, and commercialization but it is not a factor that directly influences its production, as in QMAs.

Geographical relief, topography, climate, vegetation, and rivers are all factors that influence common subsistence agriculture, economic diversification, and herd size, thereby contributing to the *terroir* of Requeijão Moreno production.

In the scenario described, the data collected was the result of the semi-structured questionnaire (Appendix A) application, primarily qualitative, through interviews conducted during visits to properties selected by the Minas Gerais Technical Assistance and Rural Extension Company (EMATER MG), from February to November 2022.

Photos and footage were recorded under a non-disclosure agreement, guaranteeing information confidentiality, defined by the Research Ethics Committee (CEP — UFVJM nº 5.345.154). Through observation, the production of the Requeijão Moreno was defined, with a proper description of the "way of making" in a flowchart. The profile of the involved families and the influence of cheese production on the family income were observed as well as the volume of milk utilized in the production, environmental information on properties and herds, marketing, cheese forming, and obtaining water used in production.

A 25% sampling of Requeijão Moreno producers was conducted in the Teófilo Otoni microregion, resulting in 13 producers selected from a total of 54. The selection considered the number of producers per municipality and their annual production based on data provided by EMATER in Table 1.

**Table 1 – Municipalities producing Requeijão Moreno, number of agro-industries, and annual production per kilogram in the microregion of Teófilo Otoni, Minas Gerais.**

| Municipalities that produce Requeijão Moreno | Nº of agro-industries | Annual production (kg) | Nº of properties visited |
|---|---|---|---|
| Ataléia | 3 | 40,000 | 1 |
| Catuji | 7 | 2,800 | 2 |
| Frei Gaspar | 0 | --- | 0 |
| Itaipé | 4 | 6,600 | 1 |
| Ladainha | 1 | 3,000 | 1 |
| Novo Oriente de Minas | 5 | 18,250 | 1 |
| Ouro Verde de Minas | 0 | --- | 1 |
| Pavão | 3 | 1,000 | 0 |
| Poté | 8 | 4,000 | 2 |
| Teófilo Otoni | 0 | --- | 0 |
| Malacacheta | 4 | 13,000 | 1 |
| Franciscópolis | 4 | 3,200 | 2 |
| Setubinha | 15 | 2,736 | 1 |

Source: EMATER MG (2020).

It is noteworthy that in Ouro Verde de Minas' case, EMATER identified only one producer in 2022. When the visits were made, the questionnaire was also applied to this producer of Requeijão Moreno.

Regarding data treatment, they were categorized and statistically quantified using Microsoft Excel. The present research can, therefore, be considered quantitative and qualitative.

The literature review was carried out through bibliographic consultations related to the topic, in dissertations and theses, relevant legislation, *homepages*, and scientific articles in electronic databases such as Scopus, Scientific Electronic Library On-line (SciELO), ScienceDirect, Web of Science, and Google Scholar. The revision, then, enabled cross-referencing and critical analysis of works carried out in the same field in different cheese-producing regions.

## Results and discussion

With the final results, it was possible to describe the traditional recipe used by the families included in the research, profile the Requeijão Moreno producers, and outline the characteristics and particularities of the cheese, as well as highlight the economic importance of this activity for the family.

### Description of the "way of making" Requeijão Moreno

The Requeijão Moreno is a type of artisanal cheese from Minas Gerais, made from naturally coagulated raw milk. It is obtained through the mixture of cooked cream with drained and washed curd mass. Its color can vary, ranging from yellow to brown; the darkest ones are the result of a chemical reaction known as the *Maillard* reaction (Sobral et al., 2022). In the case of Requeijão Moreno, this reaction affects the color from light, medium to dark brown.

The ingredients consist of naturally coagulated milk and salt, as depicted in the flowchart displayed in Figure 1. The steps and manufacturing processes are detailed below.

The amount of milk expressed is decided based on the number of cheeses to be made (which, in turn, depends on the amount of milk produced during the dry and rainy seasons). Each 1 kilogram of Requeijão Mineiro needs 10 liters of milk to be produced. Coagulation is reached through a period of resting at room temperature without additives. After that, the cream deposited on the surface is removed and reserved for later frying. It exemplifies the adaptation of this traditional production to the climatic conditions of the northeast of Minas Gerais.

After the removal of the cream, the curdled milk is heated on a wood stove in an aluminum pan. It is kept at a high temperature until it boils, when it is possible to observe the separation between the whey and the dough. At this point, the first whey removal happens; most commonly, the mass is placed inside a synthetic bag and hung on an iron hook with a bucket or basin underneath to deposit the drained whey. The first drained whey is called *bravo* (similar to "crude") and, generally, is fed to pigs, avoiding its disposal in the environment. A level of sustainable consciousness was evident through the reutilization of whey as nutritious food for pigs, associating economic activity with environment care on its territory.

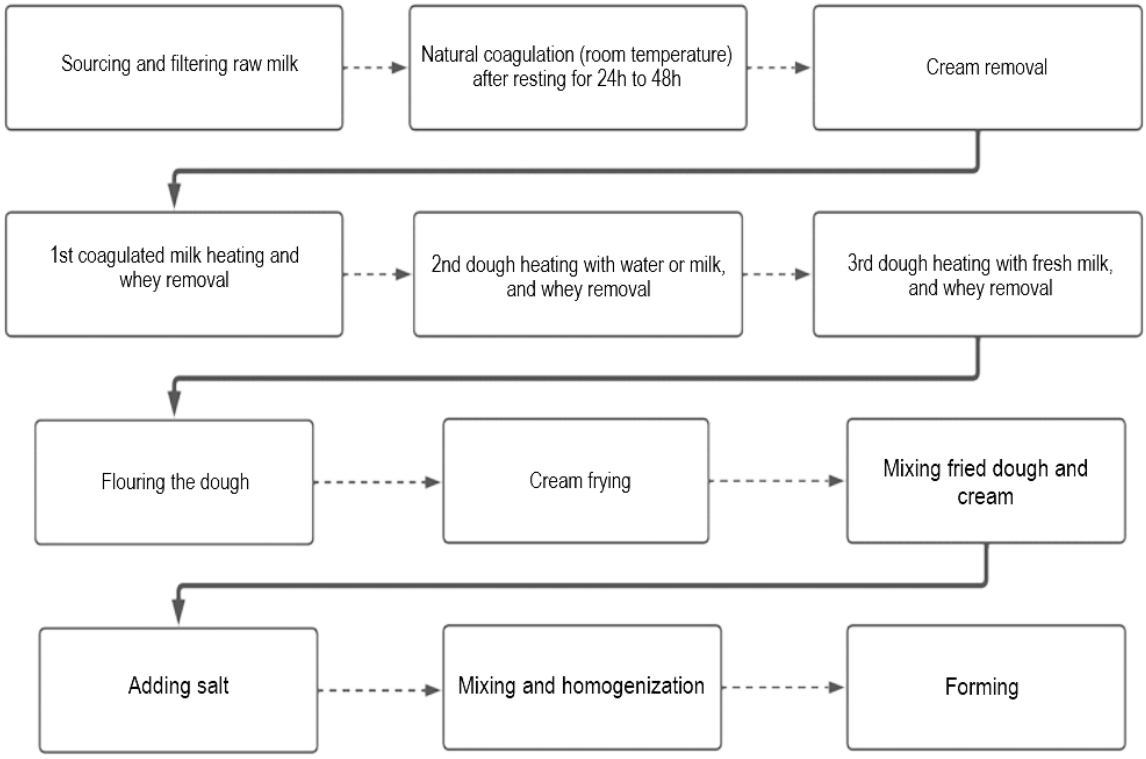


**Figure 1 – Flowchart for the production of Requeijão Moreno in Mucuri Valley (MG).**

At the second heating, the drained dough is returned to the pan with fresh raw milk or hot water (variation observed among the producers surveyed). Still at high heat, it is possible to identify another separation between dough and whey, making the dough more consolidated or "bonded" (the word most used by the producers surveyed). On the second removal, the whey called *manso* (similar to "meek") is reused by families in different ways, including making artisanal butter, dairy drinks, or coconut candy for their own consumption or commercialization.

The third and final heating is always done with the addition of fresh raw milk and, after that, the last whey removal takes place. The drained dough, crumbled or divided into portions, is set aside, while the cream removed at the beginning starts its frying process in the pan. While frying the cream, there must be uninterrupted stirring with a "wooden" spoon, usually manufactured by the producers themselves.

After the cream is fried, salt and the mass previously set aside are added. The product must be completely homogenized. This process is laborious, with vigorous stirring aiming to establish a complete mix between the dough and fried cream.

The last stage is molding while still hot, in which the finished dough is traditionally "lifted". Besides being a sign that Requeijão Moreno is ready to be placed in a mold, it can be tasted! Molds come in a variety of shapes and materials, the oldest and most traditional being rectangular wooden ones with adjustable dividers. These were the first molds used by the elders of the families and were even handcrafted by them at the time. In this "brick"-like format, Requeijão Moreno is traditionally sold in sizes referred to as "one mold" or "half a mold" in the markets. There are also round molds made of PVC pipes.

## Requeijão Moreno producers and family traditions

The "way of making" Requeijão Moreno in the Mucuri Valley is passed down through generations, evolving over the years as a result of the constant pursuit of improvements and practicality. Some families set aside specific days for production, gathering the drained dough in a refrigerator or freezer, among other adaptations, using their resources as efficiently as possible. This serves as a practical example emphasizing the vital role of communication among individuals in cultural production and the social aspect of territoriality across generations. It fosters a dynamic exchange of experiences, perceptions, and knowledge (Albagli, 2004).

The research confirmed that the production is primarily familiar, often performed in couples, with very close percentages between genders: women (55%) and men (45%). Generally, the male role is manual labor, from milking to milk transportation, passing it on to the female role, which encompasses milk straining, removing cream, dough "washing", whey removal, and frying the cream. At the end of the production, when it is time to homogenize the dough with the cream, the men usually rejoin the process.

In addition to the couple, there is also the involvement of the children. Of the total number of people involved in the production, 62% of the visited properties have up to two employees (couples), and 38% have three to four family members. Unlike an agricultural company, in family farming, the production area is also the family's living space, where decisions are taken considering more perspectives than just profit. It is the family's space for expression in all its dimensions (Flores, 2004).

When it comes to age, 40% of artisanal producers are between 56 and 70 years old — highlighting the importance of recording the traditional recipe so that it is preserved through the years. Next, the producers are aged 41–55 (30%), 18–25 (20%), and 26–40 (10%) years. According to reports from older producers, their children lack interest in the field work routine due to the difficulties caused by seasonality and exhaustive effort of cheese production. They worry about not having subsequent generations interested in continuing this family tradition. Therefore, public policies and specific legislation that support and encourage the production of artisanal cheeses are important, including initiatives that invest in the training and development of future generations (Roos et al., 2023).

The data exposes another essential fact: 70% of the owners are involved in the production of Requeijão Moreno in most of the process, if not all of it. This close involvement of the owners is a positive characteristic, as there is a greater interest in improvements and investments (if there are resources) than in outsourcing productions. Furthermore, the insertion of the family in the production process increases the opportunity for more significant gains for everyone involved, strengthening family farming and reducing rural exodus.

When asked about who taught them how to make Requeijão Moreno, 77% answered that they learned it from their parents. Some learned from grandparents or aunts (15%) and a minority learned from neighbors (7%), thus confirming the traditional production carried on through generations. The passing down of milking and cheesemaking processes, as well as other products such as biscuits and candies, is meant as a way of teaching the children a means of survival, a trade to support their families.

The surveyed producers reported never having participated in a cheese-making course or training. It is established, then, the importance of this and other research for the continuity and appreciation of the artisanal cheesemaking tradition of Minas Gerais, whether in the Mucuri Valley or in other regions.

Regarding family origins, 70% are from Mucuri Valley, born in the city where they still reside, proving to be their reference to place, history, and memory. The remaining 30% are from families originally from the Jequitinhonha Valley, referring to the history of northeastern migrations from these neighboring valleys, where families fleeing droughts sought fertile land and work opportunities (Achtschin, 2020).

As for their tenure in cheese production, 54% have been involved for 15 to 30 years, with the tradition originating from their parents or grandparents. As for the remaining producers, 31% have been producing for less than 15 years, and the minority, 15%, have been in cheese production for more than 30 years.

In regions where dairy facilities are present, the raw milk is competitive between artisanal cheese production and industry. In the QMA-producing region of São João Del Rei, for example, data from 2010 shows that 60% of the producers had been in this field for only 10 to 30 years, even though it is considered the main artisanal cheese production region in Brazil (Castro, 2015). However, in the case of Serra da Canastra, most producers had been operating in this field for more than 30 years. This longer operation time in the Canastra region is linked to the competition for raw milk, which is fiercer in São João Del Rei as it has a greater number of dairy facilities (Oliveira, 2010).

Level of education is another aspect investigated about the Requeijão Moreno producers, with the majority (62%) having incomplete primary education, followed by those with no formal education (20%). This information opens the possibility of training to improve agricultural management and production of the Requeijão Moreno. It is vital to provide opportunities for the professional development of these producers (good agricultural and manufacturing practices) to raise awareness of sustainable actions, such as the importance of animal welfare for milk production, the appropriate reuse of dairy by-products, herd health, and food safety, among others. With little to no education and few job opportunities, these producers learned from childhood how to work with agriculture and livestock, using all possible family labor. Education was not a priority, due to difficult access and large distances, according to reports from the surveyed producers.

Associating the production of Requeijão Moreno with possible visits to these rural spaces could be interesting, as gastronomic tourism is one of the economic sectors with the lowest employment barriers, as most jobs in the tourism value chain do not require much education and could include less favored social layers suffering from unemployment (Nascimento et al., 2022).

### Socioeconomic relevance of Requeijão Moreno

The lack of opportunity in large urban centers continues to direct labor to work in family farming, positively boosting the production of Requeijão Moreno and its socioeconomic importance. In the opposite direction to the rural exodus, younger generation producers are returning to the countryside with higher education degrees since they found Requeijão Moreno a source of income for their families.

Regarding family income, 62% of Requeijão Moreno producers have a total monthly income ranging 3–5 minimum wages, followed by 23% of producers with 1–3 minimum wages, and a minority of 15% with income ranging from 5–15 minimum wages. As a reference, the minimum wage in January 2023 was R$1,302.00. The observed variation between minimum and maximum income is related to seasonality, with long dry, and short rainy seasons typical of the region. During the dry season, the lower availability of milk quantity directly reflects

the reduction of *requeijão* produced. As for the "water period" (a term commonly used by producers), the opposite happens, improving these families' income. Therefore, seasonality directly influences the decision to maintain, increase, or reduce cheese production.

In the surveyed area, the monthly *per capita* income of most producers is above 1.5 minimum wages, corresponding to a total of R$1,953.00, using the same January 2023 reference. Such values exceed the average for the state of Minas Gerais, where the average monthly income *per capita* is R$1,529.00 (IBGE, 2022). This result can be attributed to the economic importance of the production of Requeijão Moreno in the Teófilo Otoni microregion.

For the majority of surveyed producers (62%), the Requeijão Moreno production contributes 80–100% to family income. For 23% of producers, the contribution is less than 30%, and for the minority of 15%, the contribution is 30–50%. The producers that depend less on cheese production have other sources of income such as delivering milk to dairy facilities and selling calves, among others typically linked to family farming.

As for the volume of monthly production, 46% of the sampled properties produce 100 to 200 kg/month, seeing double the production between dry and rainy seasons. The remaining producers are divided as follows: 23% produce from 20 to 50 kg, 16% below 20 kg, and 15% produce from 50 to 100 kg. The total production of the 13 properties surveyed is an average of 40 kg of cheese per day. This quantity is similar to the Artisanal Cheese Alagoa producing region, covering ten municipalities with production ranging between 5 and 50 kg/day (Canal Rural, 2020). However, based on the average production of milk per day, the amount could be even more significant.

In the 13 sampled properties, the milk yield averages 2,380 liters/day, considering both dry and rainy seasons, which could result in approximately 238 kg of Requeijão Moreno/day. However, an average of 40 kg/day is produced, which corresponds to only 17% of the total milk generated in the area. This result confirms that most of the raw milk produced is supplied to the dairy industry. Competition for raw milk between dairy facilities and artisanal cheese production is a reality in the Teófilo Otoni microregion, just like in other cheese-producing regions.

Producing artisanal cheeses from raw milk has benefits and differences when compared to "commodities" and "customs" in agribusiness. Family farming can be customized based on the notion of *terroir*, adding value to the product and providing a favorable economic option. In commoditization (industry), there is high dairy productivity, fierce competitiveness, and large-scale production, and the absorption of Brazilian dairies by transnational companies is commonplace (Nascimento and Souza, 2004).

Market data from March 2023, set the price of a liter of milk in Minas Gerais at R$2,48 (Milkpoint, 2023), corresponding to R$24.80 earned per 10 liters of milk. This price is lower than Requeijão Moreno's, which on average, is sold between R$45.00 and R$70.00/kg (variation observed in research carried out in 2022).

In the production area of Artisanal Cheese Alagoa, 100% of the milk produced is used in artisanal cheeses (EMBRAPA MG, 2019), while in the region of Artisanal Cheese Mantiqueira de Minas, 82% of the total milk produced by its municipalities is used (EMATER MG, 2019). This suggests that the recognition of Teófilo Otoni region as a producer of Requeijão Moreno could contribute to funneling raw milk in more significant quantities for the production of artisanal cheeses and appreciation of its traditional gastronomic culture. It is worth remembering that the raw milk used in the production of artisanal cheeses, regulated within food safety standards, provides nutrition, a unique flavor, and health, unlike pasteurized milk in the dairy industry (Bonilla-Luque et al., 2023).

Regarding the herd size of typical family farming, the majority of producers surveyed (62%) have up to 30 heads of cattle, including males and females. Of the milk used in Requeijão Moreno production, 77% is exclusively from milking inside their own property, while 15% of producers purchase milk from third parties in addition to their own. The remainder 8% make cheese exclusively with milk purchased from other producers and do not own a herd. It was observed that, during the dry season, some producers need to buy milk from third parties in order to maintain the quantity of cheese produced. Despite the municipalities participating in a region that has the same *terroir*, this action makes it difficult to control milk quality and contradicts the law of artisanal cheeses in which "the milk must be removed and processed on the property of origin".

Manual milking is predominant in the research region, and it is the most common method in other regions producing artisanal cheeses in Minas Gerais. Only one producer has bucket milkers, which are one of the simplest mechanical milking systems, suitable for small herds. In the case of this producer, 100% of the milk expressed is destined for Requeijão Moreno.

Artisanal cheese must adhere to bacterial count limits set by legislation, as it reflects the hygiene required when obtaining milk from the farmyard. However, contamination risks are higher with manual milking due to farmyard conditions and container usage. Regarding the quality of artisanal cheeses, milking management is primordial since it involves the milkers, maintaining an appropriate environment, and the health of the animals (Paiva et al., 2023).

As for cow breeds, 100% are crossbreeds without a precise definition, generally resulting from crosses between the Gir and Holstein (Girolando) breeds. Similarly, the QMAs from Serra da Ibitipoca, Serro, Canastra, Cerrado, and Araxá are produced through herds that are mostly crossbred (Costa et al., 2022).

Regarding animal nutrition, the food provided, in addition to other factors, directly interferes with the composition of the milk as well as the flavor (smell, texture, and taste) of artisanally produced cheeses. In the case of QMAs, the flavor is acquired during the maturation process (Paiva et al., 2023). The Requeijão Moreno is different, as it is not matured and still undergoes heat treatment; however, the texture

and flavor of the *requeijão* are also related to animal feeding, which leaves the mass with different levels of *liga* (bind, in producers' words), according to practical evaluation of these "master cheesemakers". The diet variation in the research region is based on seasonality and reflects on the constituents of Requeijão Moreno, making it essential to fully characterize this delicacy through both microbiological and physical-chemical analyses (continuity of research), as different compositional results will undoubtedly be obtained. In addition to the aforementioned analysis, it is important to determine the sensorial aspects of the *requeijão*, as sensorial quality is fundamental in the construction of the identity of artisanal cheeses from different regions (Ramírez-Rivera et al., 2018) while being a subsidy for the RTIQ.

In the Teófilo Otoni microregion, the cattle are pasture-raised, fed in the rain season with the abundantly available pasture of *Brachiaria* spp. or, in other cases, of elephant grass. Grass-fed cattle produce, according to researchers, milk of better quality and quantity when compared with cattle reared in feedlots, positively influencing the sensorial quality of the cheeses produced (Alothman et al., 2019). Despite the high cost of feed, it is used as a solution through draughts, supplementing the cattle's diet in the studied microregion, in addition to protein-enriched salt, sugar cane, and corn silage.

The research found that Requeijão Moreno was sold in 2021 with costs ranging between R$35.00 and R$50.00; the price went up the following year, varying between R$45.00 and R$70.00, each cheese weighing from 800 g to 1 kg. Most sales are made through social media (mainly *WhatsApp*), quickly reaching any kind of audience, from local to international, with no middlemen, at no cost to the producer. In this aspect, some benefits of globalization are observed, such as reducing distances and enabling fast access to information and direct marketing (Gonçalves, 2022), even if there is no health regularization at the moment. It is also common to informally sell in local or regional stores, at fairs, and municipal markets, as is the case with most artisanal cheeses from Minas Gerais.

The most common shape of Requeijão Moreno among the producers surveyed is round, using molds made from PVC pipes, reported to be easier to clean than the traditional wooden molds. Some producers use different molds and weights based on different consumers, demonstrating practical knowledge of customer service. However, this variation demonstrates a lack of identity. These producers are also very aware of the product quality as they do not use tricks to yield more dough, like the addition of starch or potatoes, which negatively influence the flavor and conservation of Requeijão Moreno.

The research also considered the origin of the water used in production, with 100% sourced from springs and/or shallow wells, with no use of chlorinated water. Springs and shallow wells are considered surface water (Oliveira, 2010), and it is essential to implement sustainable actions to guarantee the balance of economic activities and nature limits as well as water resources preservation.

No artisanal cheese producer associations or cooperatives were identified in the research area, with the Teófilo Otoni Rural Producers Union having regional coverage. It is worth highlighting that the 13 municipalities in this study are part of the Pedras Preciosas Tourist Circuit, which is an example of a local productive arrangement resulting from an integrative policy for the development of the Minas Gerais regions (Lima et al., 2020), with a particular articulation between associated municipalities. Formal organization can bring greater opportunities, commercial visibility, professionalism, legality, and cost reduction, among other benefits, and it may be a relevant alternative to enable regional sustainable development (Araújo et al., 2020).

Surveying available natural and cultural resources closely linked to the production of Requeijão Moreno can promote local and regional development, especially in territories with low business density and social-economic dynamism, contributing to the promotion and identification of geographical indication (GI). In Brazil, these indications are classified into indication of origin (IP; *indicação de procedência*) and denomination of origin (DO) (Araújo et al., 2020) — a recent example being Serro (MG), which was granted a protected designation of origin (PDO) identification seal (Minas Gerais, 2024).

## Conclusions

The Requeijão Moreno from Mucuri Valley is a typical family farming production, traditionally passed down through generations. It is produced primarily by couples aged between 56 and 70 years, locally born and raised, and most of them have incomplete primary education. Artisanal cheese production accounts for 80 to 100% of family income, varying through the long dry and short rainy seasons, which are typical of the region.

Production is rustic, marketing is informal, has limited economic visibility, has no standardization contributing to its identity, and has no food safety parameters despite being a much appreciated typical delicacy.

The "way of making" was recorded in a flowchart aiming to contribute to the perpetuation of this cheesemaking tradition, the result of the attributes of this *terroir* that lack producers' formal mobilization, and research regarding its physical-chemical, microbiological, and sensorial constitution.

The researched region is a potential target for local development programs based on territoriality to enhance the production of Requeijão Moreno and its *terroir* and add value to the product. The programs may enable better employment rates and income in rural areas, considering sustainable development in line with the preservation of natural heritage, with future research continuing this work.

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## Authors' contributions

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**Appendix A - Questionnaire applied to requeijão moreno producers in the teófilo otoni microregion**

**Name:**

**2. Municipality where property is located:**

**3. Owner or EMATER MG extensionist contact:**

**4. Genre:**
Female
Male
Rather not answer
Other:

**5. Age:**
18–25 years old
26–40 years old
41–55 years old
56–70 years old
Over 70 years old

**6. Marital status:**
Single
Married
Divorced
Stable union
Widower
Rather not answer

**7. Education:**
No education
Incomplete elementary education
Complete elementary education
Incomplete high school
Complete high school
Incomplete degree
Complete degree
Postgraduate
Rather not answer

**8. Monthly family income:**
Up to a minimum wage (up to R$1,045.00)
From 01 to 03 minimum wages (R$1,045.00–R$3,135.00)
From 03 to 05 minimum wages (R$3,135.00–R$5,225.00)
From 05 to 15 minimum wages (R$5,225.00–R$15,675.00)
Rather not answer

**9. What are the producer's primary sources of income?**

**10. What proportion does the production and sale of cheese contribute to family income?**
100%
75%
50%
25% or less
Rather not answer

**11. Time working as a cheese producer:**
Less than one year
1 to 3 years
4 to 6 years
6 to 9 years
10 to 15 years

**Appendix A - Continuation.**

**12. How many employees are there at the cheese factory (including family members)?**

**13. And who are they manufactured by?**
Select as many options as you wish.
Owner
Son or daughter of the owner
Collaborators
Technician
Spouse
Other:

**14. Approximately, what is the total volume of *requeijão* produced per month (in kg)?**

**15. What is the added value, per kilogram (kg), of the cheese?**
Up to R$20.00
From R$20.00 to R$30.00
From R$30.00 to R$40.00
More than R$40.00
Rather not answer

**16. How big is the herd?**

**17. What is the primary race(s)?**

**18. What is the feeding type?**
Select as many options as you wish.
Pasture
Corn silage
Sorghum silage
Sugar cane
Hay
Green grass
Corn
Soybean meal
Cottonseed meal
Mineral salt
Fish flour
Soybeans
Oat
Elephant grass
Other

**19. What is the milk origin?**
Own
Third-party
Both

**20. What is the total volume of milk expressed per day (in liters)?**

**21. What is the total volume of milk used to make cheese per day (in liters)?**

**22. What is the milking type?**
Manual
Mechanic with bucket milker
Mechanic with closed-loop
Other:

**23. What is the average cheese weight at the end of production (in grams or kg)?**

**24. What is the cheese shape at the end of its production process?**

**Appendix A - Continuation.**

**25. What characteristic(s) best defines the cheese produced?**
Select as many options as you wish.
Sweet
Salty
Bitter
Spicy
Fruity
Buttery
Fresh
Semi-hard
Hard
Creamy
Acid
Others:

**26. Who did you learn to make cheese from?**
Note: Parents, relatives? What is their origin? Northeast? Jequitinhonha?

**27. What is the most common destination(s) for the *requeijão* produced in the cheese factory?**
Municipal market
Fairs
Other cities
Online sales
Own store
Export
Other:

**28. Where does the water used to process *requeijão* come from?**
Spring
Shallow well (cistern)
Deep well
Public network

**29. Is the water used chlorinated?**
Yes
No

**30. Feel free if you would like to detail any of the production processes or peculiarities of your cheese factory.**