

# Potential and degree of interest in obtaining the protected designation of origin in the two

dairy-producing subregions in Antioquia, Colombia, as a competitiveness strategy

Potencial y grado de interés en la obtención de la denominación de origen protegida en dos subregiones productoras de lácteos en Antioquia, Colombia, como estrategia de competitividad

Potencial e grau de interesse em obter a denominação de origem protegida em duas subregiões produtoras de laticínios em Antioquia, Colômbia, como estratégia de competitividade

**Jorge Ariel Franco-López<sup>1</sup>, Juan Camilo Patiño-Venegas<sup>1</sup> y Jhoany Alejandro-Arias<sup>2</sup>**

<sup>1</sup> Instituto Tecnológico Metropolitano, Facultad de Ciencias Económicas y Administrativas  
Departamento en Ciencias Administrativas  
Medellín, Antioquia, Colombia

<sup>2</sup> Universidad de Los Lagos, Vicerrectoría de Investigación y Posgrado  
Osorno, Chile

[jorgefranco@itm.edu.co](mailto:jorgefranco@itm.edu.co); [juanpatino@itm.edu.co](mailto:juanpatino@itm.edu.co); [jhoanyvalencia@itm.edu.co](mailto:jhoanyvalencia@itm.edu.co); [javalenciar@gmail.com](mailto:javalenciar@gmail.com)

Franco-López: <https://orcid.org/0000-0002-0507-2914>

Patiño-Venegas: <https://orcid.org/0000-0002-8334-9296>

Valencia-Arias: <https://orcid.org/0000-0001-9434-6923>

**Abstract**

Protected Designation of Origin (PDO) is a key strategy for accessing competitive markets by highlighting the unique characteristics of products linked to geographic, natural, human, and technological factors. This study analyzes the potential and interest of two dairy-producing subregions in obtaining PDO recognition as a competitiveness tool. A comparative, analytical, and descriptive methodology with a mixed approach and a multifactorial experimental design was applied. Data was collected from 75 companies belonging to the production, industrialization, and marketing sectors. The bibliometric analysis revealed significant scientific development in the dairy sector. The results show that 36.5% of companies are unaware of the PDO, and that factors such as the type of link and sustainable development influence its viability, with a statistical value of 0.1819. The experimental design suggests that the combination of subregion, production link, and sustainable approach can determine the success of a regional dairy PDO.

**KEYWORDS:** designation of origin; dairy industry; dairy region; comparative analysis.

**Resumen**

La denominación de origen protegida (DOP) constituye una estrategia clave para acceder a mercados competitivos al resaltar las características exclusivas de productos ligados a factores geográficos, naturales, humanos y tecnológicos. Este estudio analiza el potencial e interés de dos subregiones productoras de lácteos en Antioquía, Colombia, para obtener el reconocimiento DOP como herramienta de competitividad. Se aplicó una metodología comparativa, analítica y descriptiva con enfoque mixto y diseño experimental multifactorial. Se recopiló datos de 75 empresas pertenecientes a los eslabones de producción, industrialización y comercialización. El análisis bibliométrico evidenció un desarrollo científico significativo en el sector lácteo. Los resultados muestran que el 36,5% de las empresas no conocen el DOP, y que factores como el tipo de eslabón y el desarrollo sostenible influyen en su viabilidad, con un valor estadístico de 0,1819. El diseño experimental sugiere que la combinación entre subregión, eslabón productivo y enfoque sostenible puede determinar el éxito de una DOP láctea regional.

**PALABRAS CLAVE:** denominación de origen; industria lechera; región lechera; Análisis comparativo.

**Resumo**

A Denominação de Origem Protegida (DOP) é uma estratégia fundamental para acessar mercados competitivos, destacando as características únicas dos produtos vinculadas a fatores geográficos, naturais, humanos e tecnológicos. Este estudo analisa o potencial e o interesse de duas sub-regiões produtoras de laticínios em obter o reconhecimento da DOP como ferramenta de competitividade. Foi aplicada uma metodologia comparativa, analítica e descritiva com abordagem mista e um delineamento experimental multifatorial. Os dados foram coletados de 75 empresas pertencentes aos setores de produção, industrialização e comercialização. A análise bibliométrica revelou um desenvolvimento científico significativo no setor de laticínios. Os resultados mostram que 36,5% das empresas desconhecem a DOP e que fatores como o tipo de vínculo e o desenvolvimento sustentável influenciam sua viabilidade, com um valor estatístico de 0,1819. O delineamento experimental sugere que a combinação de sub-região, vínculo de produção e abordagem sustentável pode determinar o sucesso de uma DOP regional de laticínios.

**PALAVRAS-CHAVE:** denominação de origem; indústria de laticínios; região leiteira; análise comparativa.

## 1. Introduction

A producer will seek high levels of productivity in order to penetrate markets; however, competitiveness is also required, which "*demands strong public-social-private collaboration in the regulation of certain economic activities and in an appropriate sectoral industrial policy*" (Estrada *et al.*, 2013: 17). Medeiros *et al.* (2019) emphasize additional systemic and dynamic factors, including innovation, market size, infrastructure, labor, and the macroeconomic context. The proposal emphasizes the enhancement of competitiveness through the Protected Designation of Origin (PDO) in the dairy sector of northern and eastern Antioquia, Colombia. As Arancibia (2016) indicates, a PDO is a designation that recognizes products with unique characteristics from their origin, reflecting quality and best practices. In Europe, the PDO is classified as a geographical indication; in the U.S., it functions as a certification mark; and in other regions, it is used as an ingredient brand (Escandón-Orellana, 2016). This approach is predicated on the principle of ensuring the authenticity of products and thwarting the proliferation of imitation, a notion that finds substantiation in the Palmero cheese case study, which demonstrated a correlation between enhanced production methodologies and sustainability (Bermejo *et al.*, 2021).

As indicated by official bodies such as the European Parliament and the Council (2012), a further advantage of a PDO is to ensure that farmers and producers receive a fair income for the qualities and characteristics of a given product or its production method. It also helps consumers make informed choices and fosters the adoption of sustainable technologies. A clear example is the Indian dairy sector, where systemic approaches improve production, traceability, and authenticity (Kaushik *et al.*, 2024). In Latin America, Villegas and Cervantes (2011) highlight

PDO cases like Morelos rice and Mexican artisanal cheeses. Ecuadorian examples such as cacao arriba, Montecristi hats, and Galápagos coffee are also mentioned. Other notable PDOs include Pisco and giant corn from Cusco (Peru), Singani and Royal quinoa (Bolivia), Cacao de Chuao and Cucuy Pecayero (Venezuela), and Colombian coffee. As Pino *et al.*, 2018 observe, La Rioja wine, established in 1925, remains Spain's oldest PDO.

In this context, dairy farming has also demonstrated its relevance as a traditional sector that can benefit from the dynamics of territorial differentiation and associated quality, as evidenced by recent studies conducted in Brazil and Colombia. These studies analyze the spatial importance of dairy farming in São Paulo (Ribeiro *et al.*, 2024) and the impact of forage supplements on productivity in dairy cows in Nariño (Nieto-Sierra *et al.*, 2020), respectively. The cases under consideration illustrate how the articulation between local practices and valorisation strategies can strengthen regional agri-food systems.

### 1.1 State of the art

The bibliometric search revealed that the dairy subsector's PDOs worldwide, ranging from 1988 to 2021 in the Scopus database (FIGURE 1), have documented research papers in 10 countries. Research has primarily focused on cheeses, animal analysis, and nutrients to improve milk quality, with relevance across multiple disciplines such as agricultural and biological sciences, immunology and microbiology, veterinary science, environmental sciences, and social sciences. Recent studies, including those by Iotti *et al.* (2024) and Ferronato *et al.* (2025), emphasise sustainability and carbon footprint in cheese production with PDOs, highlighting their role in enhancing both competitiveness and environmental responsibility.

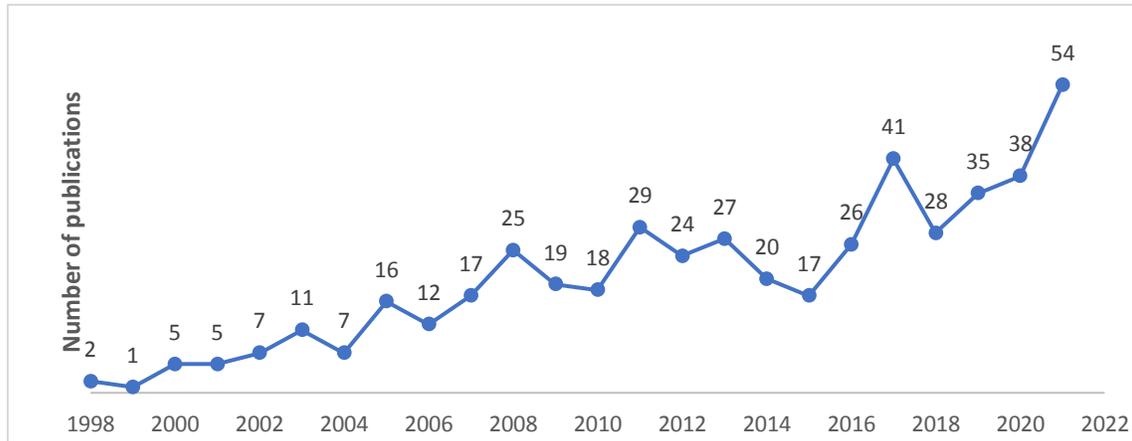


FIGURE 1. Scientific production of PDOs in the dairy sector (1998–2021). Source: Scopus, compiled by authors

This growing trend is indicative of the increased interest in PDOs within the global dairy sector. Over the course of a 23-year period, 484 works have been produced. In relation to the subject under discussion, there is a substantial body of literature on the subject, with works representing a range of cheeses. To illustrate this point, consider Mozzarella cheese, which is characterized by a high moisture content and is produced using traditional technology and direct acidification. This process results in the generation of a PDO (Natrella *et al.*, 2020). Altieri *et al.* (2020) emphasise that the authenticity of Mozzarella cheese is determined by the materials used, based on the ratio of carbon, nitrogen, and oxygen isotopes. Other studies describe PDO cheeses such as Serpa (Araújo-Rodrigues *et al.*, 2020), Idiazábal (Moran *et al.*, 2019), Sierra de la Estrella (Reis *et al.*, 2019), and Buffalo Mozzarella from Campana (Bontempo *et al.*, 2019), highlighting their unique sensory and chemical attributes.

Gaglio *et al.* (2019) present a discussion on the influence of bacterial biofilms made with seven types of wood on Vastedda (Italy) PDO cheeses, noting that wooden vats act as bacterial reservoirs essential to the cheese's unique flavour. These biofilms preserved dominant species, maintaining sensory identity. Morandi *et al.* (2019) used lactic acid bacteria to inhibit *Listeria* and other Gram-positive bacteria, protecting

both health and flavour. Uymaz *et al.* (2019) analyzed PDO Ezine cheese (Turkey), finding that non-starter lactic acid bacteria enhance product quality. In 1996, Bontempo *et al.* (2019) indicated that Buffalo Mozzarella cheese with a Protected Designation of Origin (PDO) is recognized for its tradition, influenced by environmental conditions and traditional methods. Mammi *et al.* (2018) argue that food additives improve cow's milk quality, exemplified by Parmigiano Reggiano. However, Barrios *et al.* (2016) highlight ongoing performance and technology challenges in the dairy industries of developing countries.

### 1.2 Problem situation

This concise overview of the substantial scientific advancements in the dairy sector's PDO facilitates the formulation of a proposal that aims to address the following: firstly, the level of interest in two specific subregions situated in an emerging economy (Antioquia, Colombia) and the significance of acquiring a PDO as a competitive asset in both subregions, which share a similar productive vocation. As posited by Sgroi *et al.* (2021), the enhancement of business competitiveness is a pivotal stratagem for achieving success, exerting a favourable influence on both the geographical region and the natural environment. Marulanda and Martínez (2018) describe the socioeconomic features of the Eastern subregion. The Medellín Chamber of

Commerce (CCM) (2017) outlines economic limitations in the northern subregion. Medina *et al.* (2019) emphasized soil conditions. Corantioquia (2016) reports high water usage. Delgado-Pertíñez *et al.* (2021) link environment and milk quality. Cassolini (2018) notes hygiene deficiencies. Bolívar Parra *et al.* (2020) evaluate microbial safety in Quesito.

### 1.3 Research question

The two defined regions are indicative of the dairy potential of the region and the country as a whole. Initially, and without the necessary research knowledge, two products were identified: quesito (small cheese) in the northern subregion and a cheese without yet knowing the specific characteristics that make it unique in the eastern subregion. The initial approach to the detection of a PDO gives rise to a research question that delineates the objective of the work: This study will examine the potential and degree of interest of the two subregions in achieving a PDO in their dairy sector as a competitiveness strategy. At the objective level, the research focuses on analyzing the potential and degree of interest of the two dairy production subregions in obtaining a PDO.

## 2. Materials and method

The research is framed within a comparative and analytical study, understood as "*an intellectual operation through which the states of one (or more) objects are compared based on at least one common property*" (Fideli, 1998; Marradi, 1991, cited in Piovani y Krawczyk, 2017: 3). The approach adopted is also descriptive, with the objective being to identify and understand the realities and unique characteristics of the object of study (Aguirre & Jaramillo, 2015). In this case, the focus is on two dairy subregions whose geographic, climatic, productive, and cultural features suggest potential competitive advantages. This demands a detailed territorial characterization and a contextualized narrative. In this sense, Younas *et al.* (2023) propose the

"MIRACLE" narrative framework to structure thick descriptions in qualitative research. This reinforces the importance of rigorously documenting the unique characteristics of the subregions studied. In their study, Guevara *et al.*, (2020) posit that the crux of the matter lies in identifying homogeneous characteristics that enable the establishment of behavioral structures in each locale.

The research method is mixed, also termed multi-methods, mixtures, or methodological triangulations, as Pereira (2011) and Ruiz (2008) designate it, signifying that this research paradigm permits the integration of quantitative and qualitative studies. To operationalize this, the study incorporated three types of perspectives, or 'links', in each dairy subregion—producers, industrial processors, and marketers—to assess potential and interest in the PDO. The producer category refers to cattle herds, the industrial to processors, and the marketer to distribution agents. A structured survey was used to gather data. Casas *et al.* (2023) describe this as a research technique that collects a series of representative data from the population, with a view to exploring, predicting and explaining characteristics. The survey format included 10 questions, as shown in TABLE 1, aimed at obtaining general insights into the subregions and offering a preliminary overview of the information regarding the PDO.

Thereafter, contact was initiated with all relevant stakeholders in the dairy production sectors within the two subregions, resulting in the compilation of a total of 74 records. From this dataset, a random sample of respondents was then selected for further engagement. The data obtained were processed using a comparative analysis approach and multifactorial experimental design, with a view to identifying emerging themes and patterns that enrich the factors influencing perceptions of dairy products in the study subregions. As illustrated in FIGURE 2, the responses obtained from each subregion and link are presented.

TABLE 1. Question format for the 3 links in the dairy subsector. Source: own elaboration

Variable	Question
v0	Category
v1	Company name
v2	Subregion
v3	How many years has the company been established?
v4	In which municipality is your company located?
v5	How many employees do you have in your company?
v6	What products does your company offer?
v7	Do you know what a designation of origin is and its impact on sustainable development?
v8	What kind of products are produced in the region where you are located?
v9	What product do you consider to be the most representative of the region?
v10	Do you consider that dairy products are produced with respect for the environment (sustainable development)?

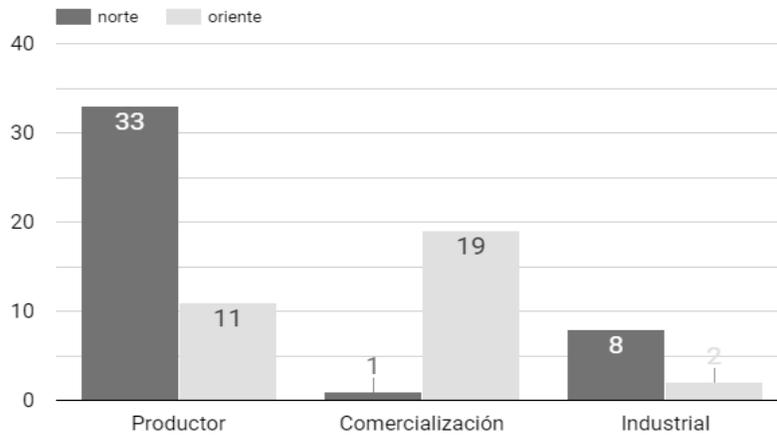


FIGURE 2. Survey responses for each subregion and link. Source: Prepared by the authors

The northern subregion has the highest production in the region, accounting for 70% of total production. The largest producer population is located there, with a total of 33 responses from one marketer and eight industrial producers. In the eastern subregion, 11 records were obtained from producers, 19 from marketers, and two from industrial producers. Finally, at the methodological level, the collected data were analyzed, coded, and the responses categorized.

### 3.1 Descriptive comparative analysis

In the course of the survey conducted in order to ascertain the respondents' knowledge of the PDO, the following responses were obtained: 63.51% of respondents were unaware of the term 'PDO', while 12.16% of production links in the eastern subregion and 10.81% in the northern subregion were familiar with the term. As illustrated in FIGURE 3, the data is broken down to show the details for each link and subregion.

## 3. Results

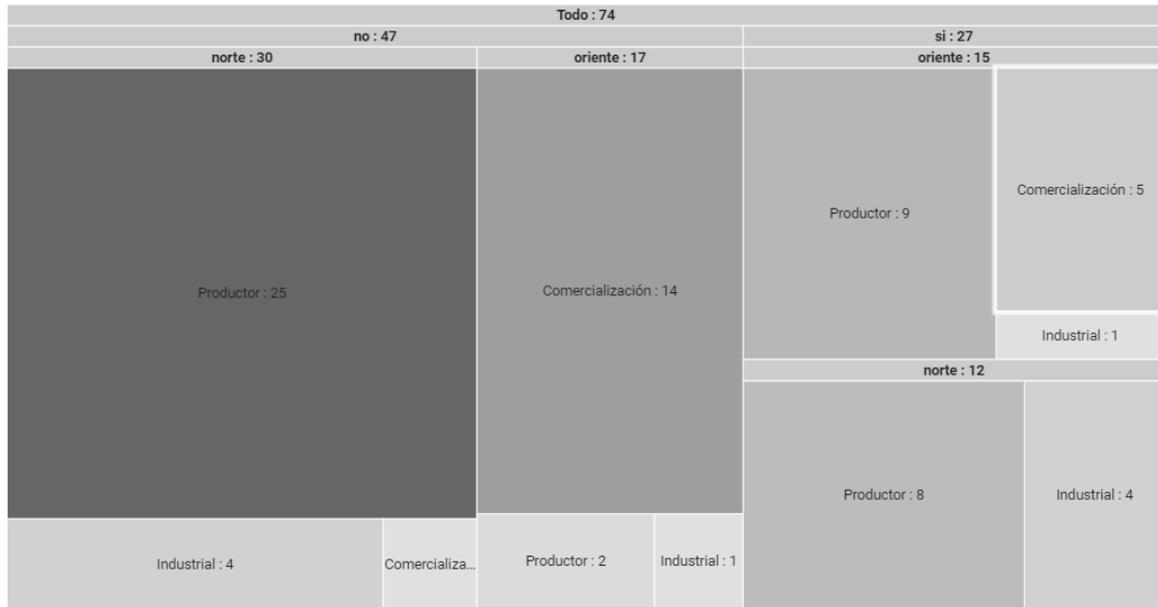


FIGURE 3. Knowledge of PDOs by link in subregions. Source: prepared by the authors

The responses obtained in the eastern dairy subregion demonstrate that the majority of respondents understand the PDO as a competitiveness factor. As illustrated in FIGURE 4, the majority of companies engaged in the

production, marketing and industrial links of the dairy sector are situated in the northern subregion of the department, accounting for 56.8% of all relevant entities.

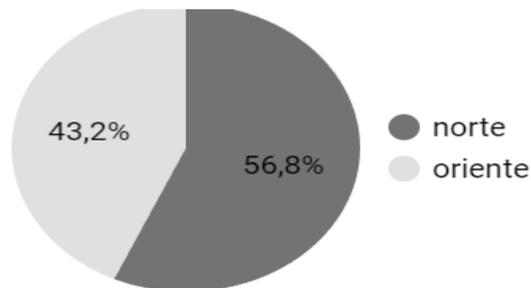


FIGURE 4. Company participation in the survey by dairy subregion. Source: prepared by the authors

The northern subregion is comprised of 17 municipalities, of which it is notable that the dairy subregion is represented by six localities. Similarly, the Eastern subregion is comprised of 23 municipalities, of which a mere 9 have been

recognized for their dairy production. As illustrated in FIGURE 5, the responses for each link in the production chain are represented for each of the subregions.

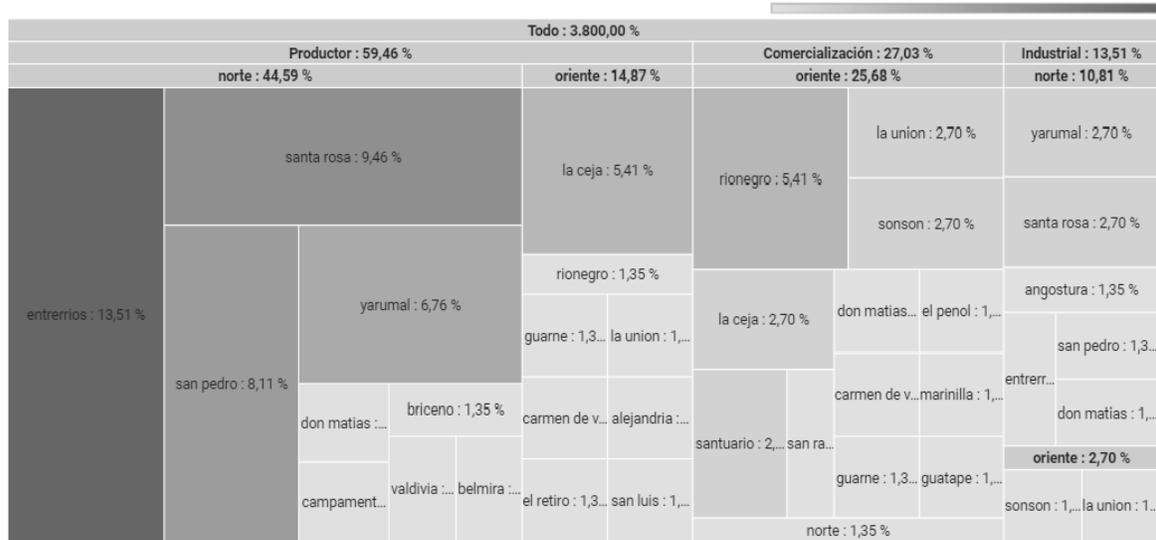


FIGURE 5. Responses for each dairy subregion and production chain. Source: prepared by the authors

The responses obtained from each locality demonstrate the level of interest in searching for PDOs as a competitiveness factor. An essential preliminary undertaking in the identification of

PDOs within each designated subregion was the determination of the predominant product types, as illustrated in FIGURE 6.



FIGURE 6. Products produced in each dairy subregion. Source: prepared by the authors

As illustrated in FIGURE 6, the most representative products for each region are indicated. In this case, 32 companies in the Northern region identified milk as the most significant product, while a mixture of cheese and milk was recognized to a lesser extent by companies in the Eastern region.

In the Northern subregion, milk is the most prominent product, while in the Eastern region, cheese is the most significant. Furthermore, the survey revealed some of the most common problems for producers, which are highlighted in FIGURE 7 for each subregion.

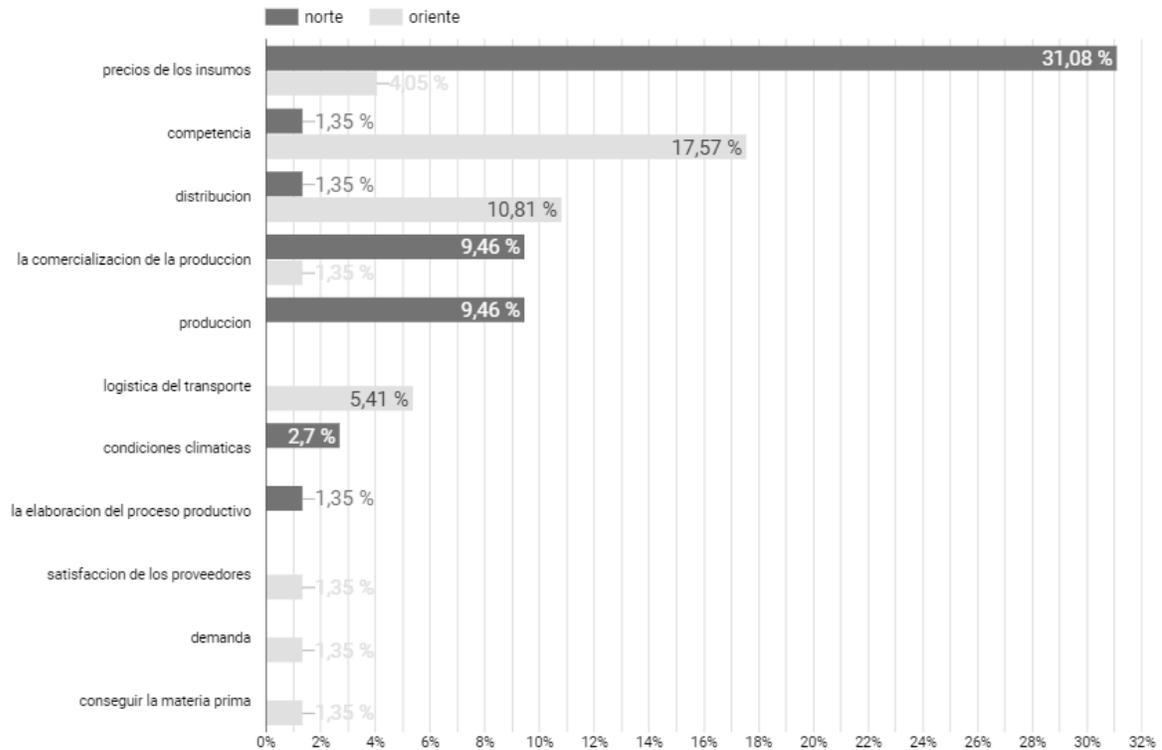


FIGURE 7. Difficulties faced by producers in dairy subregions. Source: prepared by the authors

In order to obtain the PDO, productive activity in each of the links must face various challenges. The northern subregion struggles with high production input costs, while the eastern subregion faces competition and distribution issues. The northern link is mainly productive, complicating marketing efforts, unlike the eastern subregion, which faces logistical difficulties. The high cost of agricultural inputs in the north is critical, as *"the prices of agricultural raw materials have increased substantially. Depending on the type of good, their price has doubled and even quadrupled in relation to manufactured goods."* (Roitbarg, 2021: 3). The

OECD-FAO (2018) explains this increase as resulting from high per capita consumption of agricultural goods. Market competition in the east must be analyzed, although a *"dynamic market where there are no barriers... will result in more options for consumers."* (Tassano, 2016: 106). Godás (2006) highlights the strategic role of distribution in the production chain, involving logistics, channels, and points of sale.

### 3.2 Multifactorial experimental design

A multifactorial experimental design was developed to ascertain which factors or combinations of factors influence the PDO

process. This methodology pertains to an approach entailing the simultaneous manipulation of multiple independent variables or factors under study (Beg & Rahman, 2021). The primary objective of this study is to analyze the manner in which these variables interact and affect a dependent variable within a controlled environment (Metteler *et al.*, 2014). This design facilitates the exploration of not only the primary effects of each factor, but also the interactions between them, thereby enabling a more profound comprehension of causal relationships.

The primary applications of this methodology are threefold: firstly, to investigate and optimize processes; secondly, to evaluate treatments; and thirdly, to understand complex phenomena (Telford, 2007). The data obtained from the survey were used for three variables considered important for establishing a PDO (Salamon *et al.* 2016), resulting in a 2x3x2 design with the number of companies as the dependent variable.

From this, seven hypotheses are proposed in the multifactorial experimental design to evaluate its effects, as follows:

HYPOTHESIS	SUPPOSED
1	The subregion does not have a statistically significant effect on the dependent variable
2	The type of business does not have a statistically significant effect on the dependent variable
3	Subregion and type of business do not have a statistically significant effect on the dependent variable
4	Sustainable development in DOP does not have a statistically significant effect on the dependent variable
5	The subregion and sustainable development in DOP do not have a statistically significant effect on the dependent variable
6	The type of link and sustainable development in DOP do not have a statistically significant effect on the dependent variable
7	Subregion, link type and sustainable development in DOP do not have a statistically significant effect on the dependent variable

Source: own elaboration

The model that represents the experimental design is presented below:

$$Y_{ijk} = \alpha_i + \beta_j + \gamma_k + \alpha\beta_{ij} + \alpha\gamma_{ik} + \beta\gamma_{jk} + \alpha\beta\gamma_{ijk} + \varepsilon_{ijk}$$

Where:

Y = Number of companies

$\alpha$  = Subregion (North, East)

$\beta$  = Type of link (Producer, industrial, marketer)

$\gamma$  = Sustainable development in PDO (Known, unknown)

$\alpha\beta$  = Combination of factors: subregion and type of link

$\alpha\gamma$  = Combination of factors: subregion and sustainable development in PDO

$\beta\gamma$  = Combination of factors: type of link and sustainable development in PDO

$\alpha\beta\gamma$  = Combination of factors: subregion, type of link, and sustainable development in PDO

ANOVA was applied to test the hypotheses of the experimental design, serving as a statistical technique to compare groups and detect significant differences. In a multifactorial design,

ANOVA assesses the effects of two or more independent variables on a dependent variable. It divides total variance into between-group and within-group components. If the between-group

variance significantly exceeds the within-group variance, it indicates that at least one group differs from the others (Molugaram & Rao, 2017).

The results shown in TABLE 2 support this conclusion and confirm the presence of significant differences among the groups.

TABLE 2. ANOVA result multifactorial experimental design. Source: own development

Variable	Quadratic sum	Degrees of freedom	Statistic F	PR(>F)	Comparative
<b>Subregion</b>	8.33E+06	1.0	3.01E+05	0.612324	Do not reject H1
<b>Link type</b>	7.20E+07	1.0	2.60E+06	0.181998	Reject H2
<b>Region: link type</b>	2.00E+08	1.0	7.23E+06	0.054734	Reject H3
<b>Sustainable development DOP</b>	3.33E+07	1.0	1.20E+06	0.333998	Reject H4
<b>Region: sustainable development DOP</b>	2.13E+07	1.0	7.71E+05	0.429463	Reject H5
<b>Link type: sustainable development DOP</b>	8.20E-23	1.0	2.97E-24	1.0	Do not reject H6
<b>Region: link type, sustainable development DOP</b>	1.28E+08	1.0	4.63E+06	0.097879	Reject H7
<b>Residual</b>	1.11E+08	4.0			

It is evident from the results and, moreover, in consideration of the hypothesis acceptance criterion, that the following relationship must be established:

$F < Pr$  statistic (F): The hypothesis is not rejected, it is accepted.

As demonstrated in TABLE 2, an analysis of the statistics employed for the evaluation of hypotheses reveals the following findings: firstly, the subregion associated with hypothesis 1, and the intersection of the variables Link Type and sustainable development in PDO, linked to hypothesis 6, exhibit no statistically significant impact on the number of associated firms within the PDO. However, the type of link and sustainable development in PDO hypotheses 2 and 4 have a statistically significant effect on the number of linked firms in the PDO research. Furthermore, the interactions of hypotheses 3, 5 and 7 have been found to be statistically significant.

## 4. Discussion

### 4.1 Comparison with other studies

The findings of this research reveal that, despite the productive and cultural potential of the dairy subregions of northern and eastern Antioquia, a low level of awareness about the Protected Designation of Origin persists. This represents both a challenge and an opportunity. In other regions of the world, the consolidation of products with PDOs has been shown to be an effective strategy for strengthening regional competitiveness, provided that the product's identity is articulated with agroecological conditions and differentiated production practices. For instance, Gagliano *et al.* (2025) demonstrated that the sensory and physical-chemical characteristics of Parmigiano Reggiano cheese exhibit significant variation depending on the type of forage consumed by livestock. This underscores the necessity to consider local variables such as diet, environment, and traditional practices in the characterization of products with PDOs.

In this sense, technological innovation also plays a strategic role in the positioning of dairy products with a territorial identity. Luo *et al.* (2025) demonstrated that the incorporation of functional polysaccharides into products such as goat's milk yoghurt can enhance their nutritional and technological properties without compromising their authenticity. From a regulatory and public policy perspective, it is essential to accompany these differentiation processes with robust institutional frameworks. Products derived from raw milk have garnered mounting attention for their nutritional benefits, microbiological richness, and connection with artisanal practices, as emphasized by Cains and Wales (2024). However, these products are subject to stringent sanitary control standards. Additionally, as Sarma *et al.* (2025) have demonstrated, factors such as producer attitudes, perceived control, and social norms shape adoption intentions, requiring training, trust, and organizational development throughout the production chain.

Finally, it is imperative to advance research processes that not only physicochemically characterize products with PDO potential, but also comprehensively and contextually document the relationship between territory, culture, and production practices. The 'MIRACLE' narrative framework proposed by Younas *et al.* (2023) offers a relevant methodological approach to capture these complexities, thereby enabling a more comprehensive understanding of the symbolic, economic and ecological value of local dairy products.

#### 4.2 Implications

The study identifies clear opportunities to promote regional development through the recognition of dairy products with Protected Designation of Origin (PDO). This status can serve as a strategic instrument to differentiate regional offerings, facilitate access to specialized markets, and enhance the added value of traditional products. To achieve this, it is essential that producers, processors, and marketers receive training and technical support to understand the

value of PDOs and the requirements for obtaining them.

From a technological perspective, integrating traditional practices with functional innovations can boost competitiveness. Advances in microbiology, nutrition, and preservation allow for the creation of new product lines aligned with consumer demands for healthy, natural, and sustainable foods. This requires strong collaboration between producers, research centers, and rural development organizations.

In the social and organizational context, the success of a PDO strategy depends on factors such as actor cohesion across the production chain, territorial identity, and openness to innovation. Therefore, interventions must combine technical assistance with participatory processes, local governance mechanisms, and incentives for associative development, aiming to consolidate a strong and sustainable territorial identity.

#### 4.3 Future research

It is recommended that the results obtained be used to derive key recommendations for the guidance of future research. Firstly, further qualitative studies are recommended in order to understand the reasons underlying the low level of awareness of PDOs in certain subregions, particularly those with a high concentration of companies, such as the northern subregion. This would facilitate the design of targeted training strategies, taking into account the cultural, logistical and economic particularities of each territory. In addition, subsequent research endeavors could encompass the integration of supplementary variables pertaining to local public policies, accessibility to sustainable production technologies, and inter-firm cooperation networks. These variables have the potential to exert influence on the adoption of PDOs as a means of differentiation and competitiveness strategy.

Secondly, the multifactorial experimental design revealed no statistically significant effects between the combinations of subregion, type of link, and awareness of PDOs. Consequently, future research should explore potential

mediating or moderating variables, including company size, the educational attainment of those responsible, access to formal markets, and membership in trade associations. These factors may provide a rationale for observed variations in the implementation of practices aimed at sustainable development with PDOs. Furthermore, the execution of longitudinal studies would be pertinent in order to evaluate the progression of knowledge and the adoption of PDOs over time. Such studies would also ascertain the actual impact of PDOs on the competitiveness and sustainability of dairy production systems.

Finally, it is recommended to develop interdisciplinary approaches that integrate economic, environmental, and social perspectives in the study of PDOs. This will facilitate the development of more robust and contextualized models that consider not only production factors but also the structural conditions that determine the viability of implementing PDOs in territories with differentiated realities. In addition, geospatial and value chain analyses could be incorporated to identify territories with the greatest potential for PDO recognition, thus facilitating strategic decision-making by public, private, and community institutions.

## 5. Conclusion

The geographical provenance of a product is of paramount importance for the PDO, particularly in the primary sector (agriculture, livestock), such as the production of dairy products and certain artisanal processes. The geographical origin of a product provides a context, whether historical and/or cultural, that supports the authenticity and tradition associated with the product. Furthermore, it enables consumers to identify and appreciate its specific characteristics, thereby engendering trust and ensuring quality and legitimate origin. The guarantee of authenticity and added value is also provided, with the preservation of local traditions and the stimulation of economic development in producing regions being further promoted. The multifactorial experimental design presented associations for regional decision-making and for

the dairy subsectors in each subregion. The findings indicated that the PDO is a significant factor, irrespective of geographical location, and that the various links in the production chain are also of importance. Moreover, sustainable development is imperative for attaining such certification, given that the contemporary world is grappling with the acute consequences of environmental protection. It is imperative to emphasise that the presence of these dairy products is predominantly observed in extensive rural areas, where the practice has been perpetuated by successive generations of farmers who depend on this activity as their primary source of revenue. Consequently, the acquisition of a PDO functions as a letter of introduction, facilitating market entry and enhancing the quality of life for this demographic.

In summary, the PDO is founded on the principles of quality and authenticity, with the objective of creating a unique product. It is incumbent upon the subregions addressed to make efforts to find products with a PDO. Consequently, the necessity to concentrate on each subregion was identified, given that, while both subregions share the same productive vocation, they also face different problems. Consequently, the various stages of production possess distinct interests, and ultimately, the fundamental element demanded by diverse global markets is that the production, in this instance dairy products, embodies environmental sustainability, signifying sustainable development. It is evident, based on empirical evidence and accumulated knowledge, that the northern dairy subregion possesses a product with the potential to be designated with a Protected Designation of Origin (PDO) status. The following query is submitted for consideration: Conversely, the eastern subregion has yet to be characterized in sufficient detail to determine whether it meets the necessary criteria for this distinction. The subsequent investigative step is to corroborate the aforementioned hypothesis from producers, processors, consumers, and experts.

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