


SUSTAINABLE DIALOGUES: UNIVERSITY, TANNERY INDUSTRY AND ENVIRONMENTAL RECOVERY IN THE TERRITORY OF SAN BENITO <https://doi.org/10.56238/sevened2024.033-009>**Dora L Gómez-Aguilar¹ and Blanca F Rodríguez-Hernández²****ABSTRACT**

This article presents the impact of the collaborative dialogues between the university, tannery companies and the territory of Tunjuelito, carried out within the framework of the project "Development of life skills (HpV) applying Good Manufacturing Practices (GMP) in tannery industries with the extraction of collagen from Wet Blue (WB) shavings". This project, organized by the National Pedagogical University and the Ministry of the Environment, was developed in Tunjuelito, particularly in the San Benito Ecoefficient Industrial Park Association (Asopiesb). The initiative is aimed at promoting the Sustainable Development Goals (SDGs) 3, 6, 8, 9, 11 and 13, promoting environmentally responsible practices, a transition to the circular economy through the conversion of WB into collagen and the recovery of the Tunjuelo River.

During the process, life skills were promoted in three areas: in the cognitive area, entrepreneurs recognized the environmental problems associated with their sector and considered innovative solutions, such as the use of artificial intelligence to optimize processes; emotionally, they reflected on the impact of their business decisions on environmental and community well-being; In the social sphere, dialogue and collaboration between businessmen, academics and community representatives were promoted to build joint solutions.

This interdisciplinary approach to education, technology and sustainability promotes future spaces for collaboration between the university, the business sector and the community, configuring a platform for the gestation of tangible changes towards a better quality of life in the territory and the development of future sustainable interventions.

Keywords: Life skills. Territorial dialogues. Wet blue shavings. Sustainability. Social responsibility.

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INTRODUCTION

The tannery industry faces significant challenges in balancing economic, social and environmental development. The United Nations Sustainable Development Goals (SDGs) provide a comprehensive framework to reduce environmental impact and improve the quality of life in this sector. In particular, SDGs 3 (health and well-being), 6 (clean water and sanitation), 8 (decent work and economic growth), 9 (industry, innovation and infrastructure), 11 (sustainable cities and communities), 12 (responsible production and consumption), and 13 (climate action) are fundamental to guide sustainable practices in the leather industry (United Nations, 2015; De Bogotá, 2015).

However, inadequate handling of chemicals, excess solid waste, and air and water pollution pose highly prevalent public health and environmental problems (Rodríguez & Cárdenas, 2023). An important global initiative to mitigate these effects is to promote the circular economy, which seeks to transform waste into useful resources. In the context of tanneries, this model promotes the conversion of *WB* into collagen, a by-product with applications in the cosmetic and pharmaceutical industries (Espinoza, 2023; Guevara Ruiz, 2024).

In addition, the strengthening of territorial dialogues between the university, industry and the community contributes to the implementation of sustainable practices and the development of life skills in the sector. In San Benito, these dialogues allow the university to act as a mediator, providing knowledge and tools that guide entrepreneurs towards the adoption of good manufacturing practices (GMP) and the protection of the Tunjuelo River (Díaz-Canel Bermúdez & Fernández González, 2020).

THEORETICAL MARCO

THE SDGS AND THEIR RELEVANCE IN THE TANNERY INDUSTRY

In the tannery industry, the United Nations Sustainable Development Goals (SDGs) provide a comprehensive framework to promote balance between economic, social and environmental development; in this industry, SDGs 3 (health and well-being), 6 (clean water and sanitation), 8 (decent work and economic growth), 9 (industry, innovation and infrastructure), 11 (sustainable cities and communities), 12 (responsible production and consumption) and 13 (climate action) are relevant (Naciones Unidas, 2015) in the adoption of practices that reduce environmental impact and improve the quality of life of workers ((From Bogotá, 2015). However, the leather industry is one of the causes of the most common public health problems, generated by the improper handling of chemical products,



the amount of particulate matter in the air, soil and/or water and the excess of solid waste that is generated negatively impacts the environment (Rodríguez & Cárdenas, 2023).

CIRCULAR ECONOMY IN THE TANNERY SECTOR: TRANSFORMATION OF WASTE INTO RESOURCES

One of the global initiatives, which are led to mitigate the linear economic paradigm (extract, produce and dispose) is to train citizens who reuse the waste generated in their industries, who reuse, recycle and promote a circular economy that reduces waste and becomes useful material, in tannery companies, therefore, this economy promotes the transformation of wet blue waste into collagen, a by-product with commercial value in the cosmetic and pharmaceutical industry, especially ((Espinoza, 2023; Guevara Ruiz, 2024).

TERRITORIAL DIALOGUE: COLLABORATION BETWEEN UNIVERSITY, INDUSTRY AND COMMUNITY

Another paradigm shift that has been strengthened in the last decade is territorial dialogues, conceived as collaborations between various actors, especially the University, the industrial sector and the community and/or local policies, to address environmental and social challenges in an integrated manner; This approach fosters the implementation of sustainable practices and the development of life skills in the communities involved (Díaz-Canel Bermúdez & Fernández González, 2020): this cooperation promotes the implementation of sustainable practices and the development of HpV in the communities involved, in this sense, in San Benito, the territorial dialogue allows the current university as a mediator, providing knowledge and tools that guide entrepreneurs in the tannery sector towards the adoption of GMP and contribution to the recovery of the Tunjuelo River, to respect for the life of any species, that is, for life itself.

The tannery sector in the town of Tunjuelito faces significant environmental challenges due to its industrial practices, which affect water quality and surrounding ecosystems, particularly the Tunjuelo River. This issue highlights the need to implement sustainable practices and adopt circular economy models that mitigate environmental impact and promote community development. In this context, the National Pedagogical University, in alliance with the Ministry of Environment and the Association of Ecoefficient Industrial Park of San Benito (Asopiesb), developed the project "Development of Life Skills (HpV) applying Good Manufacturing Practices (GMP) in Tannery Industries with the Extraction of Collagen from Wet Blue Shavings". This project seeks to integrate the



Sustainable Development Goals (SDGs) 3, 6, 8, 9, 11 and 13, encouraging a transition towards more environmentally responsible processes.

The San Benito neighborhood is located in the town of Tunjuelito south of Bogotá D.C., an industrial, commercial and residential neighborhood, which represents 81.33% of the country's tannery sector, which, taking advantage of the proximity of the Tunjuelo River, discharge chemical inputs (chromium salts, sodium sulfide, slaked lime, etc.). ammonium sulfate, sodium bisulfite, enzymes, formic acid, acetic acid and sulfuric acid among others) and solid waste such as split leather, trimmings, sanding dust and shavings that have the highest load of organic matter (including wet blue or tanned leather shavings with high chromium content) (Galdos, Ramírez, & Villalobos, 2020; Sánchez Sánchez, Villamil Silva, & Pérez González, 2023).

The importance of this project lies in the urgent need to reduce the effects of tanning practices on the environment and the community. Through dialogue between the university, industry and the community, it is intended to raise awareness about the environmental impact and establish a collaborative approach to the recovery of the Tunjuelo River. In addition, the project encourages the development of life skills, essential for the adaptation of entrepreneurs to new, more sustainable production models.

Despite regulatory advances, the implementation of sustainable practices in tanneries remains limited. A lack of technical knowledge and resistance to change in the sector hinders the adoption of circular processes, such as the transformation of Wet Blue into collagen. The project addresses this gap through GMP training and raising awareness among local actors about their role in the sustainability of the territory.

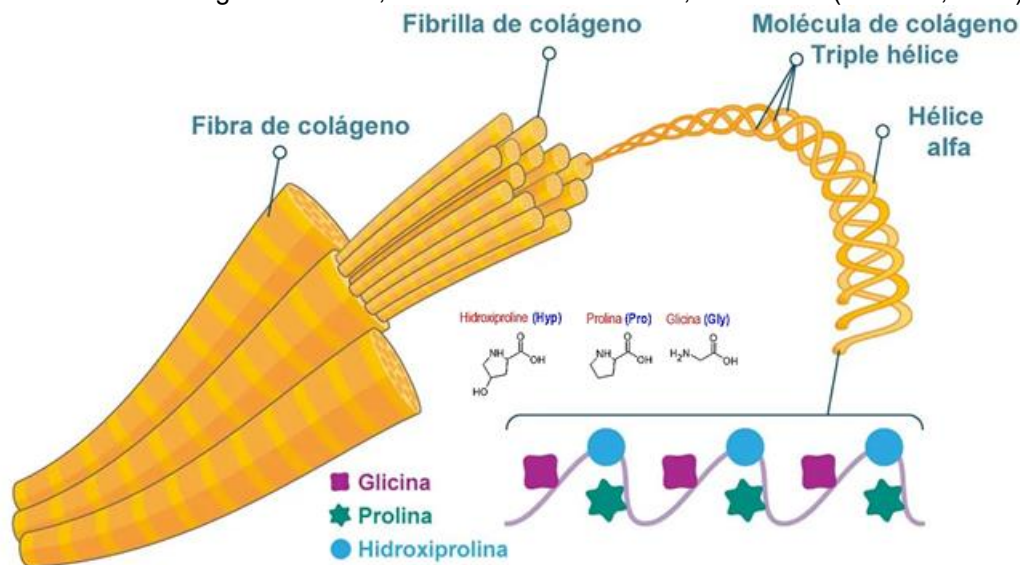
GOOD MANUFACTURING PRACTICES (GMP) IN THE TANNERY INDUSTRY

Good Manufacturing Practices are essential standards that ensure the correct handling and processing of products, reducing risks for both employees and the environment (Castellano Blandón, Lira González, & Monjarréz Picado, 2017). The application of GMP in tanneries not only helps to reduce the negative impact of the industry on public health and the environment, but also fosters a culture of sustainability and social responsibility within companies (Ayala-Garcia & Janssen, 2024). GMPs, integrated into the SDG framework, represent a key step towards sustainability in the tannery sector, driving practices that protect both workers and the surrounding ecosystem.

HYDROLYZED COLLAGEN AS A SUSTAINABLE BY-PRODUCT

Type I collagen, extracted from the shavings of chromium-tanned leather (WB), is a structural protein widely used in regenerative medicine and cosmetic products due to its properties to improve skin elasticity and firmness (Jiménez Cruz, 2014). The production of collagen from this waste represents a sustainable alternative that promotes the circular economy and reduces dependence on virgin resources. This practice not only contributes to the reduction of industrial waste, but also opens up new business opportunities for the tannery industry in alternative sectors, thus promoting economic diversification and sustainability.

Illustration 1 Collagen formation, from amino acids to fiber, taken from (Connect, 2019)



LIFE SKILLS (HPV) AND THEIR ROLE IN ENVIRONMENTAL EDUCATION

HPVs contemplate a series of skills (cognitive, emotional and social) that allow people to face and relate in a healthy way to the challenges and problems of daily life, challenging them to put into practice their knowledge, attitudes and values acquired in the course of life, make conscious and informed decisions, communicate assertively and effectively, however, this ability is linked to social support and to environmental and cultural factors in which people are immersed (Pardo Molina, Pinto Escobar, & Ruiz Arango, 2021). To promote the development of HpV in entrepreneurs, they are invited to participate in a training process for three days through the secretary of environment, in which 32 entrepreneurs registered and 22 attended, on the first day they are invited to participate in the calls for accompaniment and incentives offered by the secretariat, The results of the University's research are socialized around the findings of chromium residues, especially in water, soil, as well as alternative ways to mitigate these pollutants, on the second day,



entrepreneurs are invited to the University, so that they can learn about alternative ways to transform Wet Blue into collagen and the third day is carried out in their territory, to dialogue and establish emerging lines of rapprochement and awareness, as well as the exchange of cultural, technical, academic knowledge and research carried out by these companies to carry out a circular economy, to begin to consolidate ties between the different entities that lead to the fulfillment of the SDGs, the improvement of the quality of life of the population and especially that social responsibility with the river is identified, the people, the environment, that there is social and environmental justice (Ayala-Garcia & Janssen, 2024; Galdos et al., 2020; Pardo Molina et al., 2021).

The development of each of the stages made it possible to characterize the absorption conditions of the wet blue chips that would allow to obtain a high efficiency of chromium removal in synthetic and real wastewater (from the tanning stage), as well as to structure a pilot model of chromium removal from wastewater from wastewater. which favored the interest of businessmen in participating in the meeting coordinated by the Secretary of Environment between the businessmen of the territory of Tunjuelito, the university, thus allowing the promotion of HpV such as those unveiled through open dialogue to pronounce their fears to the participation of local proposals arising from the legislative entities, the identification of environmental problems in the sector, as well as the possibilities of working together with academic and technical institutions that accompany them in the processes and research that they carry out as entrepreneurs. In the same way, they learned about the results of research on the effects on health and the environment, tools such as Artificial Intelligence (AI) to optimize or accompany their research in addition to strengthening emotional skills, creating awareness about the impact of their decisions as entrepreneurs on the community and the environment, at a social level, the participants showed collaborative skills, where respectful, supportive and academic dialogue showed joint solutions that tended to the circular economy, but especially to recover the Tunjuelo River and biodiversity through GMPs.

The results show that sustainable dialogues between the university, industry and the community are key to driving the change towards a circular economy in Tunjuelito. The application of GMP and the production of collagen from Wet Blue show the potential of sustainable practices in the tannery sector, establishing a model that can be replicated in other industrial communities with similar environmental problems.



DEVELOPMENT

The research methodology had a mixed approach with exploratory-descriptive scope, carried out over a year, in four methodological phases (documentary review, design and implementation of a pilot model for the use of solid waste (wet blue) and a pedagogical and didactic strategy that favors the development of HpV, compliance with the SDGs proposed, as well as the circular economy and finally, By analyzing the results, new possible research can be established that strengthens territorial dialogues, the care of life, the planet and that all actions are for the common good.

In the phase of extraction and chromium-free purification of chromium-free collagen from wet blue and the design of the intervention with the entrepreneurs, a relationship of each of the phases of the research was proposed, tending to favor dialogue between the University, the Ministry of the Environment and businessmen in the territory of San Benito (town of Tunjuelito) as shown in table 1.

Board 1. List of research phases, objectives and intervention activities

PHASES	ODS	DESCRIPTION OF THE ACTIVITY	OBJECTIVE
Review of existing literature	8. Decent work. 11. Urban planning and biodiversity. 12. Production Responsible Consumption	Carrying out documentary analysis of the standardization in the extraction and purification of chromium-free collagen from wet blue	To obtain and standardize the extraction of chromium-free collagen from wet blue from the tannery industry.
		Determination of optimal conditions for collagen extraction and purification	
Research Design Development	3. Health and Wellness 6. Clean water and sanitation 13. Climate action (implicit 8, 11 and 12)	Design of observation instruments, design of didactic material that allows characterizing cognitive skills (creativity, decision-making and criticality), emotional (empathy, tension and stress management) and communicative skills (conflict resolution, interpersonal relationships).	Design the dialogic intervention between the university and businessmen (territory) with the secretary of the environment
Design, selection of intervention activities, data collection and analysis	3,6,8,11,12 and 13	Elaboration of socialization material, talk, gamifiable material with the help of AI, BPM talk – workshop. 1. A virtual day, invitation to calls with the Secretary of the Environment, socialization of research on the impact of companies' waste on the environment. 2. Day. visit to the University (academia, secretary of environment and entrepreneurs) knowledge of the process of collagen extraction from WB, new challenges 3. Day. Dialogue in the Territory (Asopiesb): awareness-raising, AI workshop and new possibilities for rapprochement	Intervene in the business sector through BPM workshop talk and dialogic meeting (3 days)

Communication of results		Evaluate the intervention and generation of emerging categories	Assessment of the scope of the investigation
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Source: The authors.

The table shows the articulation of the SDGs, the HpV that were intended to be developed by participating in the dialogues of the territory, university and secretariat of the environment, which allows evaluating the short, medium and long-term effect of the chemical substances used in the tanning process, as well as the effect on health. in the environment and generate social responsibility in the community, the family and created environmental values (Muñoz & Hernández, 2020)

RESULTS

As the interest is to evidence the results of the dialogue between the territory of Tunjuelito (the tannery entrepreneurs), the university and the secretariat of the environment, the results of obtaining collagen will be destined for another space; However, it is pertinent to socialize preliminary results of collagen extraction and standardization from Wet Blue (Tables 2 and 3) socialized to entrepreneurs, and dialogic inputs of the meeting are constituted, with the aim of generating an ethical reflection on the use of these results and being validated before marketing any type of product that can be used as raw material. where human and non-human health care prevails, as well as the environment in general.

Board 2. Physicochemical characterization of wet blue

Parameter analyzed	Datum	Photo record	Observation
pH water	4,05		<p>The contribution of protein (dermal substance-collagen) in the solid residue (wet blue) is evidenced, making visible the presence of chromium, which should be promoted</p>  <p>WB from the router</p>
Moisture %	52,40 +/- 0,11		
Ash %	4,60 +/-0,17		
Dermal substance collagen %	25,10 +/-0,46		
Crude fibre %	0,172		





Fat %	0,56 +/-0,06		
Carbohydrate %	17,20		
Cromo total %	0,48 +/-0,74		

Discarded WB shavings in the nearby neighborhood (Meissen)

Source. CIUP project DQU- 622-23

According to the data obtained, in table 2 it is observed that the protein parameter of WB (25.10%) indicates that it is a suitable material to extract collagen, however, it is observed how the proportions of tanning agents are maintained, since in the case of WB the tanning agent is chromium salts, for this a value of 0.48% is obtained. which indicates that it must continue to reduce the use of chromium to make use in other products, as a raw material.

Board 3 Characterization of collagen extracted by alkaline hydrolysis

Parameter Analyzed	Value Obtained		Norm	NTC 3750 Parameter	Photographic Record
	Wet Blue			Wet Blue1	
pH	12,78		NTC-ISO 4045	3-4 It meets this criterion because it was adjusted with H ₂ SO ₄ 0.2N	
%N	2.87 ± 0.01		NTC 1290	Minimum 1% Meets	
Total Solids (%)	4.01 ± 0.08		NTC-ISO 5433	5% Meets	
Ashes (%)	1.07 ± 0.12		AOAC 7.003/84930.15/90 (Adapted)	Maximum 1% Meets	
Heavy metals			AW 52.00	NA	
	Cr	7.73 mg Cr/100 g			

	Pb	LD<de 0,5 ppm Pb				
	Mn	LD<de 0,5 ppm Mn				
	Zn	0.12 mg Zn/100 g				

SOURCE. CIUP project DQU- 671-24

Table 3 shows the process of alkaline hydrolysis, showing that by this method the $\text{Cr}(\text{OH})_3$ (chromium hydroxide) of the WB chips is precipitated, the characterization of the pH, the percentage of nitrogen, solids and ashes, and the quantification of chromium to verify its removal, likewise, the concentration of other heavy metals was determined. such as lead, manganese and zinc, according to the Colombian technical standard NTC 3750 (Featured in 2011).

Table 4 presents the activities carried out in the three-day meeting with the entrepreneurs and the HpV developed in it.

Board 4. Favored HPVs

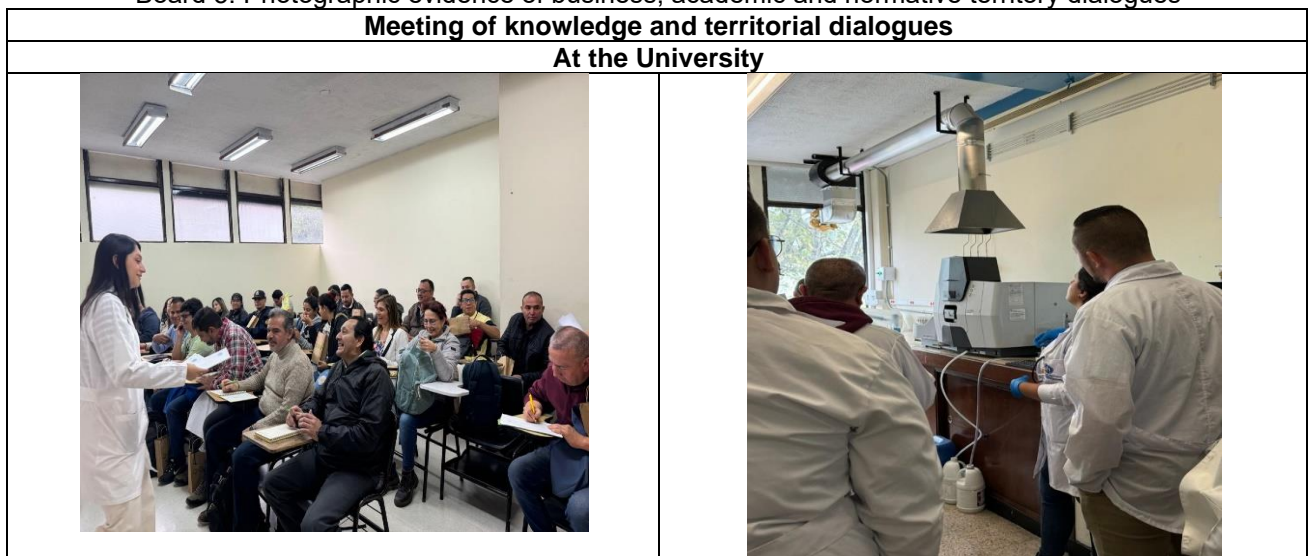
ability		Activities	Objectives	result
Emotional Skills	Empathy	Conversation with businessmen, the secretary of the environment and the university VIRTUAL CHAT exhibition of the ACERCAR call of the District Secretary of the Environment. https://www.ambientebogota.gov.co/acercar Socialization of research around the incidence of tannery products in the environment, cost/benefit ratios.	To understand the business and labor culture of the San Benito tanneries through analysis of images, discourses and cases of the neighborhood context of the tanneries. Socialize calls proposed by the Ministry of Environment to promote SDG 12 Promote interpersonal communication, both verbal and non-verbal, between employers and workers that facilitate collaboration and effective (win-win) work.	Businessmen express fear when participating in these calls, since they expose themselves to being persecuted and made visible for not complying with the rules of control bodies. Horizontal dialogue, in which businessmen question the socialized results, generating controversy and cultural, technical knowledge in the processes that distort those obtained experimentally.
	Managing Emotions			
	Stress and Stress			
Interpersonal skills	Assertive communicatio	VISIT UNIVERSITY Lecture and demonstration laboratory of collagen extraction, if as a pilot plant of wastewater to mitigate chromium.	Raise awareness among entrepreneurs about waste management and produce economic efficiency, with fewer risks to the health and life of all beings on the planet.	Comments of learning and comfort in feeling part of research and being in the university as the main actors, mitigation of factors associated with the lack of knowledge of processes typical of science but that with experience manage them.
	Interpersonal relations	MEETING IN THE ASOPIESP TERRITORY Awareness-raising discussion through infinite quota. Workshop on the use of AI to improve quality processes,	To encourage the entrepreneurial spirit and creativity of entrepreneurs to develop local meetings between people who work in tanneries to	

Cognitive skills	Problem and conflict	expand research and have current theoretical references from a critical and ethical perspective.	exchange knowledge and stimulate new forms of commercialization, leather management before, during and after the process.	They reveal the need to establish real, long-term agreements, where there is permanent accompaniment, not only for the fulfillment of an activity, so it was invited to participate in offers with entities such as SENA, if the proposal is associated with innovation or other universities according to real interests and especially that lead to the fulfillment of the SDGs.
	Self	Alternatives for the use of chromium and circular economy.	To generate a culture based on the reality of skin (with scars) that promotes the visual and odoric aesthetics of the context of tanneries, where the value is more for the meaning than for the economic value that is generated.	
	Creative and Decision Making	Presentation by businessmen about problems in the sector that require research, accompaniment, or other scenarios of dialogue between the different actors.	Train workers and entrepreneurs in digital (AI) and technological skills suitable for a circular economy, where waste is minimized and the resulting waste is processed for other products that are friendly to the environment, life and the planet.	

Source. The authors.

Table five shows the meeting at the university and the one held in the territory of San Benito, through an infinite cube, designed with artificial intelligence (AI) to sensitize entrepreneurs, the effects caused to their own territory by waste and the lack of GMP in the process, as well as guide the use of AI to learn about other tanning alternatives. the ethical, responsible sense and always of evaluating the answers given by these tools.

Board 5. Photographic evidence of business, academic and normative territory dialogues





In San Benito
Infinite Cube



Dialogue with the Ministry of the Environment, the University and the businessmen themselves



Source. The authors.

DISCUSSION AND RESULTS

1. **Strengthening the Circular Economy in Tanneries.** The integration of circular economy practices in the tannery sector, such as the transformation of *wet blue* waste into collagen, not only proved to be an environmentally viable alternative, but also generated new economic opportunities. This process illustrates how the industry can adapt to sustainability by reusing waste, thereby reducing its ecological impact on the Tunjuelo River and contributing to the Sustainable Development Goals (SDGs).



2. **Development of Life Skills.** During the dialogues, the entrepreneurs showed a remarkable growth in cognitive, social and emotional skills. The sessions helped build environmental awareness and a deep understanding of the circular economy and good manufacturing practices. This development is essential for the effective implementation of sustainable practices in the long term, strengthening the resilience of companies and promoting the adoption of new technologies, such as artificial intelligence.
3. **Horizontal Dialogue and Participation.** The project facilitated a space for open communication between entrepreneurs, academics and the community, allowing a flow of knowledge in both directions. This collaborative approach increased entrepreneurs' confidence in sustainable initiatives, although challenges were identified, such as fear of sanctions or the need for clearer regulations. The initiative demonstrated that a horizontal dialogue favors the co-creation of solutions and the commitment of local actors in environmental protection.
4. **Positive Impact on the Community and the Environment.** The implementation of Good Manufacturing Practices (GMP) and the focus on the circular economy contributed to the reduction of polluting waste in the territory of Tunjuelito. These actions highlight the key role that university-industry partnerships play in ecosystem recovery, setting a precedent for future interventions in other industrial sectors seeking a transition to sustainability.
5. **Proposal for Long-Term Strategic Alliances.** The results suggest the need to establish lasting strategic alliances between the university, the business sector and government entities to promote the adoption of sustainable practices and ensure support in the fulfillment of the SDGs. These alliances should be aimed at providing technical support and facilitating access to the resources necessary for the implementation of the circular economy, thus guaranteeing the continuity and sustainable growth of the sector.



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