

### **Patagonian fish skin tanning processes**

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#### **Abstract**

The ancient tradition of using fish skin to create clothing and accessories is shared by several coastal Arctic societies as part of their subsistence lifestyle depending on aquatic resources for nourishment and clothing.

Antarctica has no population, but the Tehuelches, Selk'nam, Yámanas and Alakaluf are some of the world's southernmost Indigenous Peoples closest to Antarctica. They live in the Patagonian region of southern Argentina, Chile, including Tierra del Fuego islands. They fish and hunt animals whose migrations in the Antarctic are a critical component of their survival.

There is not much literature regarding the use of fish skin by the Patagonian Indigenous Peoples, but they were known for the use of sea cow hides to make clothes and blankets to keep them warm and protected against the elements. The Tehuelche women spread them with chewed liver and then tan them by hand, rubbing them vigorously.

This paper evaluates the traditional fish skin tanning process used by agronomist Gabriel Fabian Trachter, this is a project promoted by the Secretary of Fisheries of the Province of Chubut in Patagonia, using a process easily adaptable to any location. The tanning was done with Mimosa extract and without any machines, allowing the development of fish skin tanning in areas with electricity deficit. The method does not intend to discard the use of drums, vats or drying tanks, but to show that it is also possible to tan without them. The results were tested at Ars Tintoria laboratory to identify the potential of this traditional tanning process with a very low environmental impact.

**Keywords:** Fish skin, Traditional tanning, Patagonian Indigenous Peoples, Antarctica.

#### **The use of hides and skins by hunter-gatherer societies**

The use of fish skin for the construction of garments is an ancient tradition shared by Arctic societies along rivers and coasts. The specific Arctic groups with historical evidence of fish leather production are the Alutiiq, Yup'ik and Athabascan of Alaska; the Nivkh, Nanai and Ulchi Siberian peoples; the Ainu from Hokkaido Island, Japan and Sakhalin Island, Russia; the Hezhen from northeast China; and Icelanders (Palomino, 2021).

The use of hides and skins by Patagonian Indigenous hunter-gatherer societies has been widely corroborated based on ethnographic information and archaeological records (Parmigiani, 2014). The study of leather technology, one of the practices that distinguished the Indigenous peoples of Patagonia, can provide valuable information to deepen the interpretation of their culture (Marchione, 2013) and contributing to contemporary vegetable tanning techniques for leather. With the objective of obtaining information on the leather technology shared and transmitted by the Indigenous populations that inhabited the Patagonia region, data obtained from ethnohistorical and ethnographic sources on these hunter-gatherer cultures are explored in this paper.

Patagonia, including Tierra del Fuego, is a huge territory, dominated in the west and south by the rugged Andean Mountain chain, and in the east by dissected plateaux giving way to low plains (figure 1). The continuous marine waterway of the Stretch of Magallanes separates Patagonia from Isla Grande de Tierra del Fuego, and the Canal Beagle cuts Tierra del Fuego from the outer islands (McCulloch, 1997).



Fig. 1: Map of Patagonia, Tierra del Fuego, Falklands and Antarctic Continent. Radefeld, Carl Christian Franz, 1788-1874. David Rumsey Historical Map Collection.

The settlements in Patagonia involving the exploitation of marine resources date back to at least the 6th millennium BCE (Emperaire, 1963). The diet of these hunter-gatherer-fisherman groups was based on the marine resources available (pinnipeds, fish and seabirds) and land resources such Guanaco (*Lama guanicoe*) and Nandu (*Rhea americana*). These groups developed navigation and hunting technology at sea that allowed for a very efficient capture, as well as the systematic use of all the raw materials provided by these preys, such bones to make tools for tanning and the use of hides and skins for clothing and footwear (Orquera, 1999).

The tradition of skin and hide tanning in Patagonia combines ancestral traditions scattered in different geographical areas. The Tierra del Fuego region was inhabited by groups of hunter-gatherer-fishermen who navigated skilfully in canoes throughout the islands. These groups were the Alakaluf (figure 2), who occupied the western sector of the Beagle Channel and the southern shores of the Strait of Magellan, and the Yámanas, who inhabited the central and eastern sector of the Beagle Channel and the islands extending south to Cape Horn (Parmigiani, 2014). They lived in small family groups with camps close to the coast exploiting the resources provided by the environment, including fishing. The Selk'nam living in the central and northern part of the Isla Grande of Tierra del Fuego were not seafarers or deep-sea hunters, however, they valued sea cow hides, which they used especially for making strong straps to carry cargo (Gallardo, 1910).

The ethnographic information about the Tierra del Fuego hunter-gatherer-fishermen, shows the importance of the exploitation of marine mammals. Regarding the use of hides, it has been documented that the fur of the seal (*Arctocephalus australis*) was used to make various items and for exchange with other hunter-gatherers' groups (Parmigiani, 2014). The 16th century chronicles from travellers mention the use of the seals' skins for clothing, canoes and huts. F. Cortés Ojeda, in 1558, mentions an encounter with a group of men whose clothes were made with sea cow hides (Gusinde, 1974). Written sources on the Tierra del Fuego canoeists refer to the variety of skins that were used to make different goods, including clothing, footwear, household goods, bags, containers, and ropes. Many of them refer in particular to pinniped skins, which have even been used for body coverings in funerary practices (Empeaire, 1963). After contact with European navigators, the skins and artefacts made from them were taken to Europe to be part of museum collections and to inform about the diversity of Tierra del Fuego's fauna (Parmigiani, 2014).



Fig 2: Alakaluf family in their canoe 1871.

The Tehuelches, the tribes of the Patagonia area stretching from the Strait of Magellan to the Negro River, clothed themselves with short-sleeved shirts, made of overlapping sea cowhides and guanaco hides (figure 3). This garment was generally tight at the waist and in the combats, they acted as armour (Guinnard, 2007).

There is little information available on how marine mammal skins were processed, apart from few ethnohistorical descriptions of the techniques used by Tierra del Fuego canoeists. The information indicates that in the past men would oversee the hunting, skinning and cutting up the animals but the depositaries of all the knowledge linked to the tanning, scraping, oiling and sewing the artefacts were women, and this knowledge was passed on amongst women and from one generation to the next (Gómez Otero, 1996).

Ethnographic sources provide data on the use of different elements for tanning the hides: fat, raw liver, liver cooked with salt, and/or with alum dissolved in water (Musters, 2005). The Tehuelche women in charge of the manufacture of leather blankets made from sea cowhides spread them with chewed liver and they tan them by rubbing them vigorously (Guinnard, 2007).



Fig 3: Tehuelche chief wearing a Guanaco leather blanket



Fig 4: Alakaluf Fuegians, dressed in guanaco skins 1882

### Patagonian fish skin tanning process

There is not much literature regarding the use of fish skin by the Patagonian Indigenous Peoples, but this paper presents the reconstruction of a leather technology tanning process from the central-northern Patagonian region. The project aims the rediscovery, preservation, reproduction, and enhancement of ancestral techniques, respectful of local traditions.

The aim of the research was to identify the biochemical logic of the traditional Patagonian tanning process using natural principles with a very low environmental impact in order to introduce them in a near future to contemporary industrial tanning, reducing the supply of chemicals, the environmental impact, generating cleaner water and less CO<sub>2</sub>. To evaluate the process, samples of salmon leather were undertaken using skin processing technology based on traditional knowledge from Patagonian communities.

The Patagonian fish skin tanning process is part of a community-based project grounded in the desire to create greater access to Argentinian fish skin knowledge. The project is led by Gabriel Fabián Trachter (figure 5), an agronomist engineer with vast knowledge on fish skin tanning techniques. Since 2016 he has developed and taught many courses on fish skin removal, conservation and tanning techniques in National Universities and job training programmes. He has published a large amount of bibliographic material on the tanning of non-traditional skins and has also worked as manager and technical consultant of several industrial tanneries.

The treatment of the fish skins has been done with natural processes and products free of harmful chemicals, using low technology methodologies, which can be appropriated by small entrepreneurs,

with an optimal use of inputs such as water, energy, and chemicals, and minimising the amount of waste generated in the tanning process, all of which are pillars of a cleaner production. The project promotes a responsible sustainable management of water and renewable resources, with a commitment to climate change. The project has been developing and rescuing steadily traditional Patagonian tanning and dyeing processes facilitating the creation of new knowledge about the fish skin craft and connecting across the Patagonian communities. The tanning and dyeing techniques of the skins has been carried out according to the traditional techniques of the inhabitants of Patagonia Argentina using autochthonous plants for tanning and dyeing as well as using Mimosa, a commercial source of vegetable tanning agent from Brazil. The project has been developed at Rawson, the capital of the Argentine province of Chubut, in Patagonia and has been directed to local communities from disadvantaged backgrounds from the remote rural areas of Rada Tilly, Sarmiento, Camarones, Rawson, Trelew and Puerto Madryn in in the province of Chubut, Patagonia.



Fig 5 to 7: Gabriel Fabián Trachter, an agronomist engineer Secretaria de Pesca de la provincia de Chubut tanning the salmon skins

The process of the fish skin traditional tanning is complicated and relatively difficult to accomplish without specialized training. The risk of disappearance of this local craft is also linked with overfishing and water pollution. Patagonian local people had applied sustainable practices in fishing for years but discarding this principle in modern times has led to the depletion of certain species. Climate change has also impacted fishing in the area. As this natural resource is reduced, the skills and technology connected to it are in increased danger of being lost (Palomino, 2021).

The project is guided by:

- Ecologically sustainable procedures, using tanning products derived from the local flora.
- Socially sustainable values, revitalising both artisanal production methods and respecting the customs of the Patagonian region.
- Economically sustainable practices, promoting the connection between artisanal manufacturing and semi-industrialised techniques.

The Patagonian fish skin project urges communities to reflect on current overconsumption and waste, to recuperate and upcycle. The aim is to learn a traditional craft with low-tech approaches and to produce a new material using the discarded fish skins from their daily diet and tanning materials available from local flora, creating a reciprocity between craftsmanship and innovation.

Fish skin tanning practices have the potential to offer important opportunities in (re)connecting Patagonian communities with common cultural heritage.

### **Mimosa tanning process**

The salmon skins were tanned with mimosa. The mimosa tannin is obtained from the bark of a tree (*Acacia mearnsii*), it is a polyphenol, of small particle size, which facilitates the penetration inside the leather that is being tanned, avoiding that it fixes superficially, which would give if this happened, a hardened leather and without being tanned in its interior. The colour it gives to the skins, allows them to be dyed in a wide range of shades, which even without having the same affinity with the various dyes that Chromium has, gives results that can hardly be obtained with some other sources of vegetable tanning agents.

An interesting aspect of the wood that provides this tanning extract is that in its bark, from which the commercial product called Mimosa is extracted, there is between 20 to 30% of tannin, with a large amount of active OH groups in this polyphenol, providing a good affinity to combine with the collagen of the fish skin.

The commercial use of this *Acacia* can be done very fast, within seven to ten years after planting, and the heartwood can also be used for other purposes. As it belongs to the Leguminosae family, it can also incorporate atmospheric nitrogen into the soil through the association of diastrophic bacteria (rhizobia) with its roots.

As with all tannins, the pH of fixation and penetration into the raw skin should be acidic, and it is better to use weak acids such as formic or lactic acid. In addition to the supply of these provided by the chemical synthesis industries, this project is advancing in the possibilities of processing in the same establishment where the hides are processed, through simple microbiological techniques (figure 8). The microbiological pickling of the fish skins was carried out using acidification with bacteria instead of lactic acid. To reach the desired pH, the water was acidified with ferments made with bacteria. These microorganisms started to develop lactic acid and a pH4 was reached with the activity of the bacteria.



Fig 8 and 9: Microbiological pickling of the fish skins

The use of mimosa extract to tan the fish skins had the objectives of transforming the skin

into leather by the formation of chemical bonds between the tannin and the collagen and the filling of the skins to improve their qualities. Using basic infrastructure and the appropriate chemical products, salmon skins suitable for any manufacturing industry were obtained. By knowing the tanning techniques, how salmon skins react to them and taking into consideration not to produce negative impacts on the environment, good results can be obtained. Likewise, if the local tanners are committed with the work they are doing, they can do it without the usual machines, which allows this activity to be carried out in areas with electricity deficit. The method does not intend to discard the use of drums, vats or drying tanks, but to show that it is also possible to tan, under certain conditions without them.

The tanning included comparative fatliquoring tests, to explain the reasons for some common defects in these skins and to show some particularities of salmon, which differentiate them from other fish species in the processes.

The fish leather was dyed without using drums, but with a lot of hand movement and rubbing the skins, so the fibres of the skins are loosened, and, in this way, there are no stains produced by sectors that react differentially with the dye. The oiling was done in a bath, with agitation during 40 min. and fixation with formic acid for 15 min. The oils used were soybean based and a mixture of soybean and fish oil.

The comparison for this type of skins between the fatliquor with soy lecithin and the mineral fatliquor is largely in favour of the former in terms of softness to the touch, flexibility, and fullness, it is also possible to achieve these results by applying this fish oil or another of animal origin manually on the underside and possibly on the grain side, thus giving other characteristics. From previous experience, oils of animal origin also have excellent results.

All the processes of the wet phase and tanning processes, were carried out by immersion with manual movement, thus replacing the action of the drums.

The tanned salmon skins have the particularity of providing a good shine when polished. The shine finished of the skins (figure 11) is the result of the friction given using a polishing machine (figure 10) with a mechanical arm and a cylindrical agate stone. If this tool is not available, it can be done by hand with smooth stones or glass bottles. Salmon has a good reaction to polishing, without the need to apply finishing products, such as modified caseins. In this case, no casein or other finishing products were used.



Fig 10: Polishing machine with a mechanical arm and a cylindrical agate stone



Fig 11: Polished salmon skins

## Fisheries waste in Patagonia

Fishery waste has increasingly been incorporated into the value chain of fishery products in countries like Iceland, generating new lines of industrial production of high value-added products. Currently, in various parts of the world, fish waste, consisting of skins, viscera, and bones, is used to produce by-products, including fish meal for animal consumption and other products such as protein concentrates, pharmaceuticals, fertilisers, glues, gelatine, and oils to tan skins (Palomino, 2020).

In Argentina, most of the companies dedicated to fish processing do not make use of the fish waste, despite the fact that the technology exists to do so on both an artisanal and industrial scale, making them a material that could be integrated as a primary or secondary input in the manufacture of clothing and accessories, and bringing together actors to integrate tanned skins from marine and inland water fish into the food value chain generating high value-added products.

The fish skins used in this project have been collected from a freshwater fishing company in Musters Lake in Sarmiento, Chubut. The skins were supplied by an artisanal commercial fisherman (figure 12) who catches rainbow trout, perch and silverside. He goes fishing daily and has several gill nets that he collects and re-sets.



Fig 12: Freshwater fishing company in Musters Lake in Sarmiento, Chubut, Patagonia. Fig 13: Filleting the rainbow trout.

Based on the recognition of the diverse geographical conditions of Argentina and its regional fish fauna, the use of different species could benefit the fish leather business. Thus, the northern region of the country could provide skins from river fish, while the eastern coastline could provide fish from brackish waters; and from the south, fish from lakes and meltwater rivers. Each type of skin could have its own palette and textures that reflect the indigenous cultural repertoire of each community.

The market study of Patagonian fish leather, carried out by the local INTI agency (National Institute of Industrial Technology) made possible to explore and measure the market need for products made from fish leather, estimating the prices at which they could be sold and detect the channels through which they could be marketed.

The improvements and simplifications in the tanning processes and the changes towards the use of organic products in tanning that have been implemented in this project, allows the adaptation of these materials to the new market trends that seek the use of raw materials with certificates of good environmental practices.

### Test Results

Several tests were carried out to understand the mechanical, tensile strength and physical properties of the tanning methods, their resistance to breakage under tension or how well the skin will perform in vigorous use. By testing the results obtained with different Patagonian fish skins



tanning techniques, we gained a better understanding of their physical properties and their limitations. The mimosa tanning technique allows fish skin to becoming a truly all-purpose material, able to be adopted for its practical as well as aesthetic capacities. The tensile strength of fish skins was tested in a dynamometer considering the acceptable values needed for different applications, sampling probes parallel and perpendicularly to backbone.

Report AN3861-21/1 Re-oiled vegetable tanned leather - dyed brown.

The resistance to tearing was good, considering the low leather thickness (0.41 mm). Normally, the minimum acceptable value of resistance to tearing is 20 N. The leather has a good resistance to tearing.

Report AN03860-21/1 Salmon leather 1 - Mimosa tanned, brown dyed, polished with agate stone. It has much better tear resistance (51N), almost twice as much as the previous one. The media thickness measured was 0,57 mm, giving a specific tear resistance value obtained reached 96,5 N/mm, which is an interestingly high value.

Regarding Martindale abrasion, the result was low due to the scales pockets (like snakes' skins).

**TEST N. 2 - Leather — Physical and mechanical tests — Determination of tear load — Part 2: Double edge tear**

*OPERATING CONDITIONS:* (23±2) °C , (50±5)% R.H. - N°of tested specimens: 3 parallel to the backbone, 3 perpendicular to the backbone

*INSTRUMENT:* Electronic dynamometer

<i>PARAMETER</i>	<i>RESULT</i>	<i>MEASURING UNIT</i>
medium thickness - parallel to the backbone	<b>0,57</b>	mm
medium thickness - perpendicular to the backbone	<b>0,52</b>	mm
arithmetic mean of medium thickness - parallel to the backbone / perpendicular to the backbone	<b>0,55</b>	mm
Average load at the parallel tear to the backbone	<b>42</b>	N
Average load at perpendicular tear to the backbone	<b>59</b>	N
Arithmetic average of the average load - parallel / perpendicular	<b>51</b>	N

Fig 13: Physical and mechanical tests. Determination of tear load.

The tensile strength of fish skins was tested applying sampling parallel to backbone and perpendicularly. The analysis of the results shows that the smallest marginal stresses occur along the backbone of fish skins and the smallest marginal deformations occur perpendicularly. This distribution of strength properties differs from the distribution of strength properties in bovine hides. The orientation of collagen fibres in a linear direction is adapted to the aquatic environment of the fish, therefore fish leather is found to be more stretchable along its length than width (Palomino, 2021).

From the results of the tests carried out on these salmon leathers, it is clear that the tear resistance is very high considering mammals leathers of that thickness, while when polished with a machine with mechanical arm and stone, this value increases almost twice as much, possibly as a consequence of the crushing of the fibres, product of the mechanical action carried out by the machine, which also produces a better dispersion of the oil incorporated in the leathers, in the oiling process. The excellent tear resistance observed is due to the peculiar fibre's orientation typical of fish skins. In other projects fish skins were already used in the footwear and leather goods industries, among others, with excellent results in terms of resistance to traction and to tearing.

**Conclusions**

Skin processing technology is based on traditional knowledge of materials: the knowledge to physically manipulate materials to acquire the properties that are needed for a specific purpose, and the ability to adapt materials and methods according to current conditions (Klokkernes,2007). Through this research we have identified the biochemical logic of the Patagonian traditional fish skin tanning process using natural principles with a low environmental impact. These traditional, environmentally friendly techniques can be used in combination with modern technology reducing the supply of chemicals, generating cleaner water, less CO<sub>2</sub> and minimising the environmental impact of current fish leather production.

The vegetable tanning of fish leather is time-consuming compared to industrial tanning and needs a different set of skills. However, it has unique properties. Regarding the hypothesis about the possibility of continuity in the practice of leather working between pre-Hispanic populations and ethnographic and ethnohistoric groups, the analysis carried out provides elements to sustain that the technical knowledge - the "know-how" - has remained in place until modern times. This work has allowed us to delve into an underdeveloped subject in reference to leather technology and its approach from ethnohistory. This proposal and the methodology used can be improved and expanded, which will enable a much richer and deeper approach to the ways of life in Patagonia's past. This paper aims to document Patagonian fish skin knowledge systems and practices which are in danger of disappearing. The paper shares fish skin skills and tanning practices that remote Patagonian communities are currently developing.

The project aims to strengthen knowledge networks between Patagonian craftspeople, disadvantaged communities and local artists. The project hopes to preserve the fish skin craft and contribute to sustainability practices through the study of the material and the transmission of fish skin tanning skills.

The fish skin manufacturing process has brought to light also finished objects such mate holders, wallets, and shoes. The adaptation of the production processes for their subsequent manufacture in the place of origin of the fish waste raw material has increased the development of local industry with the added value of aesthetic traces that carry their designation of origin so local communities can replicate them for their further commercialisation.

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