# Sequestering of chromium(III) from tanning effluents by means of biotechnology methodologies

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## Abstract

Part of the chromium(III) used for tanning is recovered from waste waters by means of a precipitation-redisolution process. Although this is a well known process, it is not possible to be applied to all waste waters generated in the tanning process. This is due to the low concentration of chromium(III) and to the presence of other substances as dyes or fats in the effluents of the post-tanning steps (retanning, dyeing, etc.).

If this chromium(III) is not recovered, it will be finally found in the sludges of the waste waters treatment plants (WWTP). This is not convenient because these sludges can not be used as fertilizers, and neither can be composted. Then its destination should be the disposal in dumps.

In this work, a biotechnological solution for recovering chromium(III) is presented. The fundamental of the process is the sequestering capacity of several fungi which may grow, develop and metabolize chromium(III).

The project is being developed by the research groups of the Igualada Leather Technology School (Universitat Politècnica de Catalunya) and Centro de Biología Molecular (Universidad Autónoma de Madrid), and several tanning factories (Curtidos Fontanellas y Martí, Curtidos Codina, Dernova, Vivapel y Curtidos Julbe).

The main goal is the development of alternative methodologies for the treatment of effluents from the post-tanning steps. The methodology is based in the chromium(III) sequestering properties by means of acidofilic fungi.

The first assays were made in the following conditions (in a laboratory scale): retanning liquors, diluted solutions, without fungicides. The results obtained show that more than 95 % of chromium recovering is possible for some fungi. At this moment, several studies have shown that there are real possibilities of applying these methodologies to waste waters of tanning processes.

**Introduction**

Wastewaters from several steps of the tanning process contain different levels of chromium(III) concentrations in addition to some other substances. The more suitable treatment for these wastewaters depends on the Cr(III) concentration but also on the presence or not of other substances.

Figure 1 shows an outline of the stages in the tanning process that generate wastewaters with Cr(III).

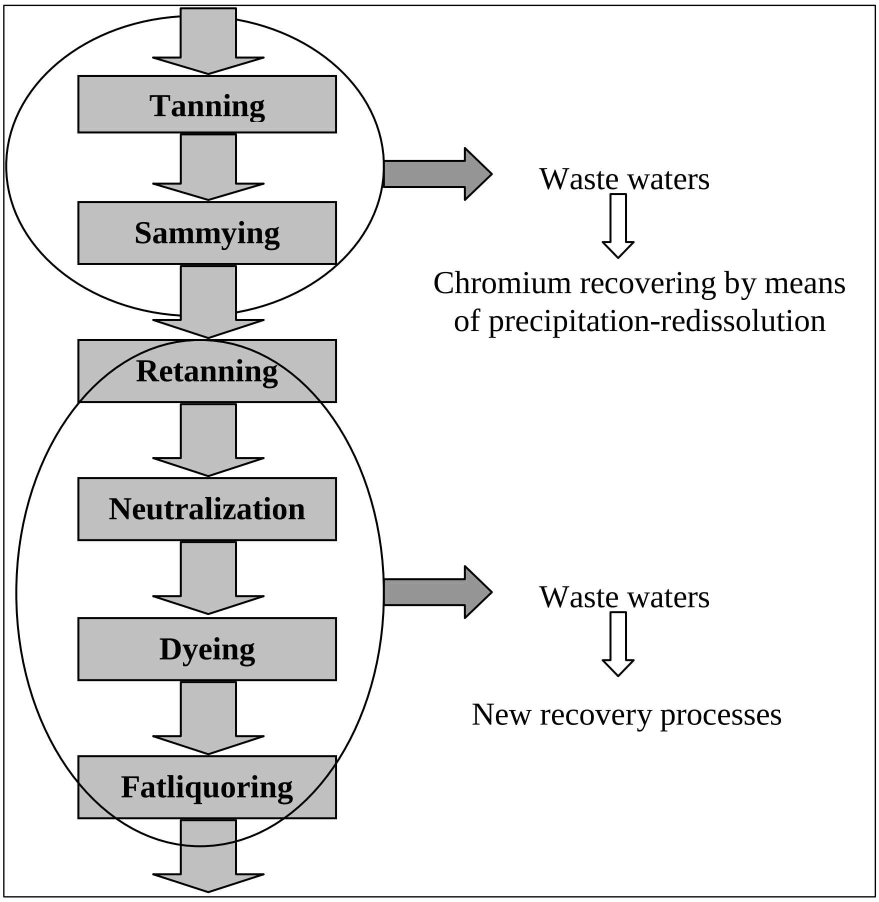

Figure 1. Outline of the tanning processes that generate wastewaters with Cr(III).

Wastewaters from the tanning and sammying stages have high levels of chromium(III), and the usual treatment is based on a precipitation-redissolution methodology in order to recover and reuse the chromium. However, for the subsequent stages, it is usually not possible to recover the chromium and thus the wastewaters must be treated jointly with other urban wastewaters in municipal plants, which are both physical and biological. In these plants, the chromium is absorbed over the aerobic microorganisms cells and is finally disposed of joined with the sludge. The result is that the sludge can not be used as fertilizer in agriculture practices, and therefore it must be disposed of in special landfills. Consequently, it would be very interesting to develop new chromium recovering strategies.

## Results

*Application of precipitation-redissolution on traditional methodology*

When the methodology based on precipitation and dissolution of chromium is applied to the wastewaters the following concentrations are obtained in the waste waters treatment plants (WWTP):

| | ppm Cr | $m^3$ / day | Kg Cr /day |
|---|---|---|---|
| Income water | 14 | 17-18 * $10^3$ | 240 |

| | mg Cr / Kg sludge | Tn sludge / day | Kg Cr / day |
|---|---|---|---|
| Sludge | 9-10 * $10^3$ | 20-22 | 220 |

These results show that a significant part of the chromium(III) eliminated from the tanneries in the wastewaters is not recovered, and finally the chromium goes mainly to the sludge. As a consequence of this high concentration of chromium the sludge becomes useless for agricultural uses or for composting. Then its destination should be the disposal in dumps.

*New biotechnological methodology*

The proposed new methodology is based on biotechnology [1,2] and the goal is to recover the chromium by means of a specific sequestering by acidophilic fungi Later, the chromium will be recovered from the fungi and reused.

The stages or the research projects carried out are the followings:

1) Systematic screening of fungi in order to select the most appropriated ones.

Table 1 shows the resistance and sequestering capacity for some of the acidophilic fungi analysed . The assays were made using synthetic chromium solutions.

| Isolated | Resistance | Sequestering (%) |
|---|---|---|
| *Penicillium* sp. Y25 | 400mM | -- |
| *Penicillium* sp. V80 | 200mM | 75% (100 mM) |
| *Aspergillus* sp. P51 | 100mM | 95% (10 mM) |
| *Penicillium* sp. P54 | 100mM | 63% (100 mM) |
| *Penicillium* sp. O26 | 100mM | 39% (100 mM) |
| *Scytalidium* sp. V86 | 100mM | 37% (50 mM) |
| 100 mM Cr = 7,6 g $Cr_2O_3$/L | | |

Table 1: Resistance to $Cr^{3+}$ and sequestering capacity for several fungi

2) Determine the sequestering capacity of the selected fungi.

Once selected the most suitable fungi, the procedure was as follows:

- expose the fungi to solutions of chromium with a increasing concentration.

- expose the fungi to wastewaters coming from the tanning process.
- study the sequestering capacity of in these conditions.

The first assays were made in the following conditions (on a laboratory scale): retanning liquors, diluted solutions, without fungicides. The results obtained show that more than 95 % of chromium recovery is possible due to the sequestering capacity shown by some fungi.

Figure 2 shows a solution of chromium and fungi. It can be seen that the fungi is growing.

Figure 2.  Growing of the fungi in a chromium solution.

After approximately ten days the fungi have been growing and sequestering the chromium of the solution as shown in figure 3.

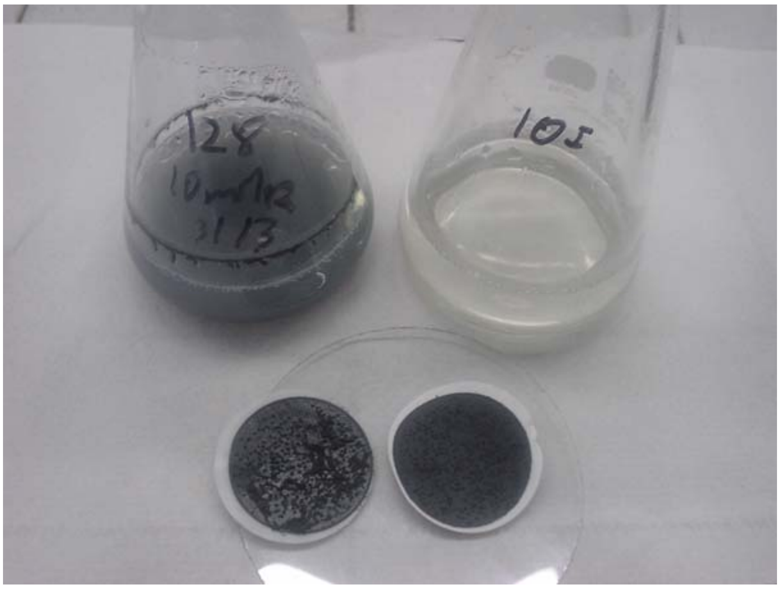

Figure 3. The chromium solution after ten days in contact with the fungi.

On left of the image we can see the mixture of fungi and chromium solution. On the right of the image we show the solution after filtration: the colourless solution proves that the chromium has been removed from the solution. The lower part of the image shows that the chromium has been retained in the filter jointly to the fungi.

## Conclusions

Fungi have proved their capacity to grow in an acid environment and with high concentrations of chromium. Moreover, the fungi sequester the metal and so it is believed that it will be possible to develop the methodology on a pilot plant scale for tanning wastewaters.
At this moment, several studies have shown that there are real possibilities of applying these methodologies to waste waters from tanning processes.

## References

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3. Durán, C., Sargeant, C., Rodríguez, N., Amils, R. (2001) Specific Cr(III) sequestering using an acidophilic fungal isolate. En “Biohydrometallurgy. fundamentals, technology and sustainable development”, Ciminelli, V.S.T., Elsevier, Amsterdam.