EVALUATION OF NITROGEN RELEASE AND THE EFFECTS ON THE SOIL MICROBIOME OF ORGANIC FERTILIZERS OBTAINED FROM WET WHITE AND CHROMIUM TANNED LEATHER

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INTRODUCTION

The tanning industry is considered one of the most environmentally unfriendly industrial activity and 3.5-4.0 million tonnes of solid waste is generated worldwide annually, of which a significant share (up to 30%) may contain chromium (Cr). In 90% tanneries worldwide, Cr(III) salts are used as tanning agents, and the solid waste contains up to 3% (w/w) Cr. In order to avoid this issue, wet white leathers are produced by combinations of synthetic tannins, vegetable tannins, glutaraldehyde and minerals, such as aluminium and zirconium.
The present work aimed to evaluate the fertilizing potential of organic N fertilizers from wet white (OFww) and basic chromium sulfate (OFCr) tanned leathers.

Figure 1. The organic N fertilizers from wet white (up) and basic chromium sulfate (down) tanned leathers.

METHODS

The organic N fertilizers (Fig. 1) were characterized (Tab. 1) and incubated for 6 weeks into the soil (Typic Xerofluvent,USDA) at 100 mg N kg^{-1} (270 kg N ha^{-1}) at 30% full water holding capacity and 20 °C (ISO 14238:2013).
Starting from the initial day, the experimental units were sampled for the determination of inorganic N (ISO 14256-2).

Table 1. The main characteristics of organic N fertilizers from wet white (OFww) and chromium (OFCr) tanned leather.

Parameter	OFww	OFCr
pH	4.8	3.8
Total Corg (%)	42	39
Total N (%)	14.4	11.3
Total Cr (%)	0.1	2.1
Cr(VI) (mg/kg)	<0.5	<0.5

At the end of the incubation, the soil samples treated with OFs were analysed for the following indicators of soil quality:
- carbon and activity of microbial biomass;
- physiological profiles of microbial communities (Biolog);
- DTPA extractable chromium.

The data obtained were processed by means of analysis of variance (ANOVA) and Tukey's HSD test was used to discriminate the differences between the means.

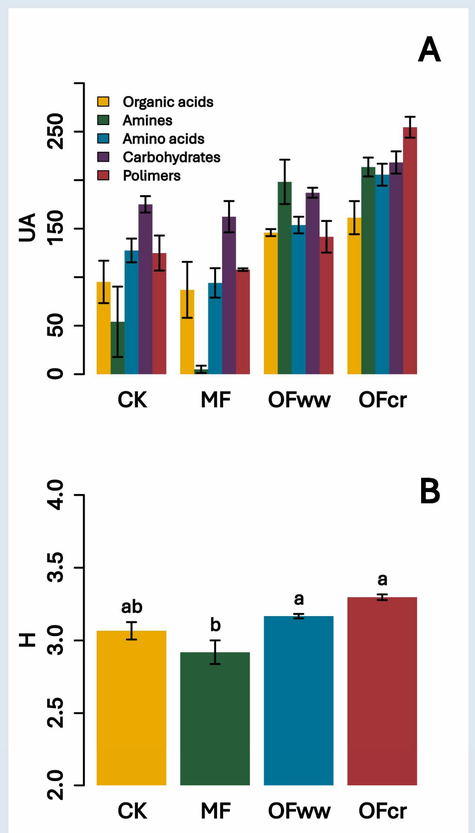

Figure 4. Response to microbial community substrate groups (A) and Shannon index of diversity (B) at the end of incubation (CK = control, MF = mineral fertilizer). Different letters indicates significant differences at HSD Tukey's test.

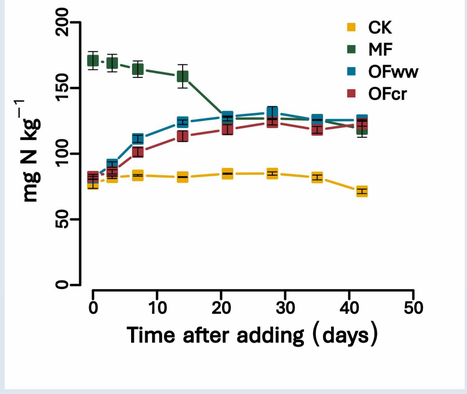

Figure 2. Trend of inorganic N (NO_3^- + NH_4^+) released from soil treated with the fertilizers (CK = control, MF = mineral fertilizer).

RESULTS AND DISCUSSION

The characteristics of the OFww and OFCr products highlighted differences between the raw materials (Tab. 1):
- total N and organic N: higher in the OFww;
- C/N ratio: lower in the OFww;
- total Cr: lower in the OFww.

The trend of inorganic N release followed the typical first order curve (Fig. 2) due to microbial mineralization of organic N: OFww and OFCr released between 45 and 50% of the total N in inorganic form.
The OFs only partially increased the microbial biomass C (Fig. 3-A), but largely increased the microbial activity (Fig. 3-B) in comparison to control and mineral fertilizer theses.
The OFs induced the increase in microbial activity as a result of the supply of organic C that can be used as source of metabolic energy.
The OFs also influenced the physiological profile of soil microbial communities (Fig. 4-A) with an increase in the microbial response to amino acids, organic acids, polymers and significantly and positively increasing the biodiversity of the physiological profiles of soil microbial communities (Fig. 4-B).
The addition of organic fertilizers to the soil increased bioavailable chromium (Fig. 5) compared to controls, but in the case of OFCr it was 5 times greater than that of OFww.

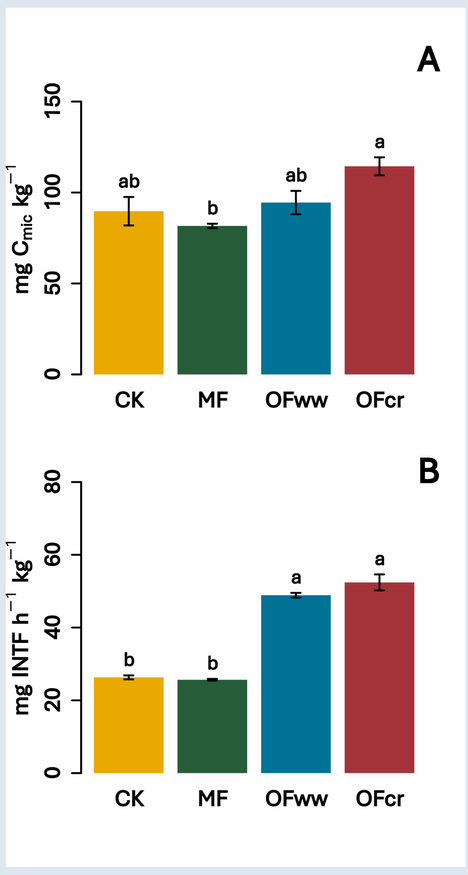

Figure 3. Soil microbial biomass carbon (A) and microbial activity (B) measured at the end of incubation (CK = control, MF = mineral fertilizer). Different letters indicates significant differences at HSD Tukey's test.

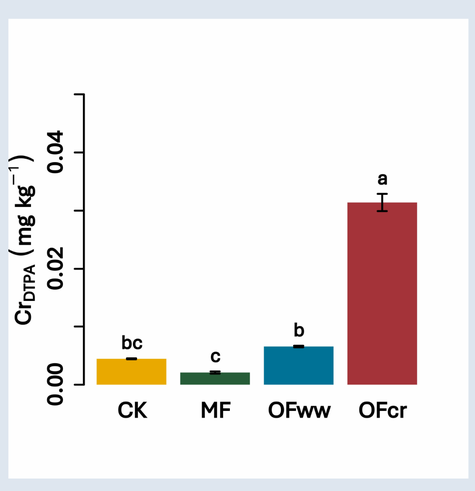

Figure 5. Available Cr at the end of incubation (CK = control, MF = mineral fertilizer). Different letters indicates significant differences at HSD Tukey's test.

CONCLUSIONS

The found effects of OFs on soil were the following:
- mineralization of organic nitrogen: not differences;
- biochemical indicators: not difference;
- physiological profiles of microbial communities: positive effect of OFCr and OFww fertilizers on the soil microbial diversity;
- bioavailable Cr: OFww showed a lower bioavailable Cr than OFCr.

The activities have highlighted that there are differences in physico-chemical characteristics of OFs obtained from leathers with different tanning. However, the effect on nitrogen release and soil microbiome was no different between the two fertilizers.
Therefore, the organic fertilizers obtained from the two different tanning processes appear to be compatible with a sustainable agriculture.

ACKNOWLEDGEMENTS

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