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## Short Communication

# Potential of wet blue leather waste for ruminant feeding

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**ABSTRACT** - The objective of this study was to find an alternative to minimize environmental contamination by leather waste using it as ruminant feed. The wet blue leather wastes (WB) without chrome extraction were compared with the leather wastes in which the chrome was extracted (CE). Both materials had 99.7% of dry matter (DM), but the crude protein level was higher (90.4%) in CE than in WB (74.3%). *In situ* effective ruminal degradability of DM was 59.7% and it was 63.1% for CP in CE. The WB did not suffer degradation in the rumen. *In vitro* abomasal digestibility of CE was 100%. The percentage of degradation per hour was higher for CE (8.2%) than for WB (0.08%). The mineral content was higher in wet blue leather wastes (10.4%) than in CE (0.4%) reflecting the chrome level and demonstrating that the removal process of this mineral is efficient. The use in animal feed is presented as a viable alternative for the disposal of waste and scrap generated by the leather tanning industry and treated by the extraction method, thus minimizing environmental contamination and providing a source of protein for animal feed.

Key Words: animal feed, degradability, digestibility, environment

## Introduction

The appropriate destination for the waste generated by tanneries has been a factor for concern among environmental authorities (COPAM 2003; CONSEMA, 2004). Among all stages of the leather production chain, the tanning stage is that which generates greatest quantities of wastewater and solid waste. In Brazil, more than 90% of tanned leather is made utilizing chromium (Teixeira et al., 1999; Pacheco, 2005). The wastes of leather tanned with chrome (wet blue) are considered Class I wastes according to NBR 10004. This means that it is dangerous to the environment and animals, including men. These wastes consist of scraping and shavings which are contaminated with chromium which prevents a conventional disposal in landfills and other uses such as animal feed.

A technology was developed (Oliveira, 2004) for the recovery of the chromium contained in the scrapings and shavings. This allows the chrome reuse in the tanning process and generates a material composed mainly of collagen as final product, with low levels of chromium. However, alternatives to use this waste must be sought out, contributing to the reduction of the tanning industry wastes disposed in the environment.

Ruminants are able to digest feed considered poor for non-ruminant species due to the peculiarities of their digestive system with microbial fermentation chambers located before the chemical and enzymatic digestion and nutrient absorption sites (Van Soest, 1994). In addition, despite the banning of foods of animal origin for ruminants in Brazil, collagen, derived exclusively from hides and skins, is one of the few animal products allowed for the feeding of ruminants by the Normative Instruction N$^{o}$ 8 of March 25 (MAPA, 2004).

The purpose of this study was to point out an alternative for the use of wet blue leather waste after chromium extraction through its use in ruminant feed characterizing its nutritional potential for these species.

## Material and Methods

Evaluations of the chemical characteristics of the product were performed in duplicate on composite samples of wet blue leather waste (WB) and on the leather waste treated by the method developed by Oliveira (2004), to minimize the chromium content (CE). The dry matter (DM) determination was performed using a ventilated oven at 60 °C

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for 72 hours and subsequently at 100 °C for 24 hours. The crude protein (CP), the ether extract (EE) percentage and the ash percentage were determined according to the AOAC method (1970). The amount of non-fiber carbohydrates (NFC) was estimated by difference, according to the equation NFC = 1 - (CP + EE + Ash), assuming that the amount of fibrous carbohydrates was negligible, because the feed was of animal origin. To determine the mineral matter profile, atomic absorption spectrophotometry was used.

The evaluation of *in situ* degradation was performed according to methodology described by Pereira & Armentano (2000), in samples of WB and CE, obeying an exponential trend according to the equation: Qt = Q0 * t * e-Kd, where Qt is the amount of material at any time, Q0 is the concentration of material at time zero, Kd is the fractional rate of ruminal degradability of the material and t is the time. Composite samples of each material consisting of three subsamples were used. The incubation times of the bags in the rumen were 0, 12, 24 and 96 hours. Five grams of the sample dried at 55 °C, corresponding to a ratio of 18.5 $mg/cm^2$, were placed in each bag (120 nylon fibers, 52 µm porosity and dimensions of 9 × 15 cm). Four cows with cannula in the dorsal sac of the rumen were used. The effectively degraded fraction (EDF) of dry matter was calculated using the mathematical model: EDF = A + B * kd/(kd + kp), where: A - The fraction (soluble fraction) assumed to be the disappearance of the sample in the polyester bags at time 0; B - fraction B (potentially degradable fraction) obtained by the equation B = 100 - (A + C); C - fraction C (indigestible) estimated from the waste in the bags incubated for 96 hours; kd - fractional rate of degradability of fraction B, determined by linear regression over time 0, 12 and 24 hours using the natural logarithm of the waste weight of each bag after subtraction of the fraction C; kp - fractional rate of ruminal passage, taken as 4% per hour.

Data were analyzed by the feature Proc Mixed of SAS (Statistical Analysis System, version 9.1) with incubation time as repeated measures using first order autoregressive covariance structure according to the Akaike criterion, according to the following model: $Y_{ijk} = \mu + L_i + C_j + e_{ij} + T_k + L*T_{ik} + e_{ijk}$, where: $\mu$ = overall mean; $L_i$ = the effect of the incubated leather waste (i = WB, CE); $C_j$ = effect of the cow (cow j = 1, 2, 3 and 4 ); $T_k$ = the effect of incubation time (k = 0, 12, 24, 96 h); $L*T_{ik}$ = interaction effect; $e_{ijk}$ = residual (error term used to test treatment effect and interaction between leather and time).

The abomasum conditions were reproduced *in vitro* using simulated gastric juice with a solution of hydrochloric acid (HCl) and pepsin. Samples were incubated for 48 hours at 40 °C with 6 mL of 20% HCl and 10 mL of 5% pepsin. Abomasal digestibility was calculated by weight difference between the incubated material and the residue at the end of incubation (AOAC, 1970).

Data were analyzed by Proc GLM (Statistical Analysis System, version 9.1) using the following model: $Y_{ij} = \mu + L_i + e_i$, where: $\mu$ = overall mean; $L_i$ = the effect of the incubated leather waste (i = WB and CE) and $e_i$ = the experimental error.

## Results and Discussion

The DM content of the two types of residue was 99.7%. As expected, WB showed a higher content of mineral matter in comparison with CE (Table 1), determined primarily by the high chromium content before its extraction.

The chromium extraction process is efficient because it draws 99.6% of this element from the leather waste (Oliveira et al., 2004). The lowest percentage of mineral matter in the CE was associated to a higher percentage of crude protein (Table 1) indicating that this material has potential for use as feed. The treatment for removal of chromium increases the CP content and at the same time makes the material more degradable in the rumen and more digestible in the abomasum (Table 2). The effectively degraded fraction (EDF) of DM and CP of the tested materials differed greatly probably due to the stability of the residue linked to the chromium, which could prevent the action of enzymes produced by rumen microorganisms.

The WB has a stability afforded by the tanning process which does not allow any act of degradation in the rumen, and this stability is lost when the material goes through

Table 1 - Major nutrients and minerals of the leather residue without extraction of chromium (WB) and of the leather residue that underwent chromium extraction (CE)

| Nutrient (% of DM) | WB | CE |
|---|---|---|
| Crude protein (CP) | 74.3 | 90.4 |
| Ether extract (EE) | 1.3 | 1.4 |
| Mineral matter (MM) | 10.4 | 0.4 |
| Non-fibrous carbohydrates[1] | 14.0 | 7.8 |
| Chemical element (mg/kg of DM) | | |
| Potassium | 0.15 | 0.14 |
| Calcium | 0.60 | 0.48 |
| Magnesium | 0.44 | 0.08 |
| Iron | 133.0 | 70.0 |
| Manganese | 2.0 | 1.0 |
| Zinc | 5.0 | 10.0 |
| Chrome | 2,7150.0 | 84.7 |

DM - dry matter.
[1] The percentage of non-fibrous carbohydrates (NFC) was estimated by the equation: NFC = 1 - (CP + EE + MM) assuming that the amount of fibrous carbohydrate was negligible.

the of chromium extraction process, as demonstrated by Oliveira et al. (2008). It is this loss of stability that probably increases ruminal degradability and the abomasal digestibility (Table 2).

As CE has high protein content with high EDF in the rumen and high abomasal digestibility, this material shows potential for ruminant nutrition, especially in view of its capacity to transform the dietary protein into microbial protein in the rumen (Argyle & Baldwin, 1989). The protein of the CE itself could be a good source of amino acids when it reaches the abomasum and small intestine and it has the potential to undergo chemical and enzymatic digestion (Satter, 1986; Robinson et al., 1995). When comparing CE with other feed of animal origins such as feather meal and blood meal, for example, we note that all have high protein content. However, these other products have a higher percentage of protein non-degradable in the rumen, but this protein has post-ruminal digestibility lower than the CE.

Still, despite its high abomasal digestibility, the CE is unlikely to be effective in inducing the desired amino acid profile for high lactating cows, since the protein is highly degradable in the rumen, unless technologies that preserve the CE from the rumen degradation are developed. The potential of abomasal degradation was lower for WB and higher for CE (Table 2). This potential digestibility superior to other available feeds of animal origin even indicates the possibility of utilization of this waste with low level of chromium in non-ruminant animal feeding, such as pigs and carnivores.

Given the potential of CE for nutrition of both ruminants and non-ruminants, its use for animal feed becomes attractive, once it is an alternative in the lowering of production costs and at the same time reduces environmental pollution by waste from the tanning industry.

Table 2 - Ruminal degradability and abomasal digestibility of the leather residue without chromium extraction (WB) and of the leather residue that underwent chromium extraction (CE)

| Degradability parameter (%) | WB | CE | SEM[1] | P |
|---|---|---|---|---|
| EDF of the dry matter[2] | 0.0 | 59.7 | 1.3 | <0.001 |
| EDF of the crude protein[2] | 0.4 | 63.1 | 1.6 | <0.001 |
| Soluble fraction | 10.5 | 4.5 | 0.01 | 0.03 |
| Degradable fraction | 11.4 | 94.9 | 0.7 | <0.001 |
| Non-degradable fraction | 88.6 | 5.1 | 0.7 | <0.001 |
| Fractional degradation rate (%/h) | 0.08 | 8.02 | 0.004 | <0.001 |
| Abomasal digestibility | 60.1 | 100.0 | 0.012 | <0.001 |

[1] Standard error of the mean.
[2] Effectively degraded fraction of the dry matter and of the crude protein considering the passage rate of 4%.

## Conclusions

The high crude protein content of the leather residues that undergo chromium extraction indicates that they can be used as a protein supplement in animal feed. The technique of chromium extraction of wet blue leather residues, with consequent attainment of leather waste without chrome, makes this material highly degradable in the rumen and highly digestible in the abomasums, providing it with great nutritional potential.

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