Valorisation strategies of Spent Coffee Ground as an ingredient for ruminants

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Introduction

Hotels, Restaurants and Caterings (HORECA) sector consists of establishments which prepare and serve food and beverages. As a result of this activity, it generates huge amounts of Spent Coffee Grounds (SCG), being the ratio of generation is around 2 kg of wet SCG from 1 kg of coffee consumed.

Most of this SCG is landfilled despite having high nutritional properties for other industrial applications, which involves high management costs and environmental impacts.

Several studies have demonstrated that SCG has high potential to be reused as secondary feedstuff for animal feed (1, 2, 3). However, its high lignin content limits its inclusion percentage in diets to use it as a functional ingredient in the concentrate (5-10 % inclusion) instead of as an ingredient with a higher inclusion percentage (more than 10 %).

Pre-treatments such as enzymatic hydrolysis are presented as an effective bioprocess for pre-digestion of lignin, which would allow increasing the inclusion percentage of this ingredient.

Material and methods

The SCG samples were collected from HORECA sector in the region aim of study (north part of Spain).

The pre-treatments aim of study were heat treatment, crushing and enzymatic hydrolysis and it was defined in 3 full factorial designs.

The heat treatment was carried out in an autoclave at 121 ºC for 15-30 and 45 minutes to facilitate the enzymatic action after the heat treatment.

The crushing was performed with the objective of analysing the effect of crushing combine or not with the enzymatic hydrolysis in the in vitro digestibility of SCG.

The hydrolysis kinetic was performed at laboratory-scale using a Sell Symphony 7100 Bathless Dissolution Distek equipment (Distek Inc., North Brunswick, USA), controlling and monitoring temperature, time and stir speed. The following commercial enzymes Celluclast®; Ultimase®; Viscozyme®; Ultrafló® and Laccase® (Novozymes A/S, Bagsvaerd, Denmark) were selected as the most appropriates for fibre hydrolysis based on bibliography and previous research. The best hydrolysis conditions for each enzyme were applied. The hydrolysis was inactivated by temperature at 90 °C for 15 minutes. The samples were centrifuged (2,650 x g; 15 min; ambient Tª) and the solid fraction was separated for animal feed, whereas the liquid sample was removed.

The nutritional value of the prototypes was measured by applying the Association of Official Analytical Chemists (AOAC) Official Methods. Then, a digestibility test was carried out with the aim of determining its digestibility.

Results and discussion

Compared to the process control (hydrolysis process but without enzyme addition), the action of Viscozyme® and Ultimase® enzymes showed a significantly greater release of sugars, a decrease in cellulose (11.2 %) and an increase in protein, with no differences in digestibility. Even so, when compared to SCG without any treatment,

the hydrolysis processes with any of the enzymes studied, significantly decreased the digestibility of the ingredients (between 27 and 30 %), due to the release of compounds into the liquid medium that are not recovered in the final product, and therefore, decreases nutrient availability.

In the case of the heat treatment, autoclaving the samples did not improve the digestibility of SCG. In addition, times longer than 15 minutes led to a significantly decrease in the efficiency of the rumen fermentation process, mainly due to an increase of fibre fractions.

The crushing process showed a tendency to increase in vitro digestibility mainly due to the decrease of the lignin fraction and an increase in fat and protein percentage. Therefore, crushing pre-treatment could improve the ruminal fermentation process compared to the SCG without any treatment.

In the case of supplementing a typical dairy cattle ration with the liquid fraction obtained after the hydrolysis processes, it decreased the digestibility (from 70 % to 48%) of such a ration without reducing VFA production. However, it improved the efficiency of the rumen fermentation process and reduce protein degradation in the rumen.

Conclusions

Coffee ground is a by-product with a high fibrous content which makes it difficult to include as a digestible raw material in animal feed. The hydrolysis process could have been a valuable strategy to make the raw material components more accessible to the animals, however, the effect of releasing compounds of interest (sugars, polyphenols...) into the liquid medium during processing makes the resulting material less valuable. Furthermore, the effect that enzymes can have on the solid matter is counteracted by the enzymatic action of the ruminal bacteria. On the contrary, the liquid fraction can be an alternative to commercial growth promoters.

The heating pre-treatment is of no interest for improving digestibility and therefore, increasing the percentage of inclusion of SCG in ruminant feeds. On the contrary, crushing is presented as the best technological alternative to improve the digestibility of coffee grounds in particular and the fermentative process in the rumen in general.

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