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Characterization of concentrated second cheese whey

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ABSTRACT
The residual deproteinized whey known as second cheese whey or "Sorelho", is a byproduct obtained from whey cheese manufacture. It is commonly obtained in small/medium scale cheese plants and, although it has little to no commercial value, it is produced in relatively high volumes, which results in a complex disposal process. Therefore, the objective of this work was to characterize the nutritional composition of two concentrated deproteinized wheys (sheep and goat), obtained through ultrafiltration/diafiltration with a 10 kDa membrane followed by freeze-drying. From the nutritional standpoint, it was possible to observe that after ultrafiltration, samples were mostly comprised of protein 75-58% (w/w). Samples also exhibited a low mineral and lactose contents (1.7-3.9% (w/w) and 0.93 -69%(w/w), respectively). The fatty acid composition profile was predominantly composed of short- and medium chain fatty acids including butyric, caproic and caprylic acids, with long chain fatty acids, such as palmitoleic, rumenic, trans vaccenic, docosapentaenoic and docosahexaenoic acids being also detected in both goat and sheep Sorelho, but in the goat Sorelho the concentration was bigger of these fatty acids. When regarding the amino acids identified aspartic acid, glutamic acid, alanine and tyrosine were the most predominant amino acids found in the sheep Sorelho while in the goat Sorelho aspartic acid, glutamic acid, asparagine, threonine and valine were prevalent. Overall, these results provide some insights into Sorelhos' potential usage as source of bioactive compounds for posterior incorporation into foods.

1. INTRODUCTION
Whey cheese is a dairy product produced mainly from ovine or goat cattle milk in the Mediterranean countries [1]. "Requeijão", the Portuguese name of traditional whey cheese is manufactured from raw or pasteurized skimmed milk through heating of whey at temperatures between from 90 to 100 °C for 15–30 min, with or without the addition of 10 -20 % of ovine/caprine/bovine milk [1]. The residual ''deproteinized'' whey called Sorelho or as second cheese whey, contains approximately 60% of the original dry matter of whey. Despite residual fat and non-thermally precipitated nitrogen components being also present, lactose and minerals are the main components of Sorelho dry mass, making it an environmental threat and impeding its direct disposal without treatment [2]. Hence, attempts to recover some of these components

before final disposal is of great interest. The objective of this work was to characterize the nutritional composition of two freeze drying concentrated deproteinized wheys (sheep and goat), obtained after the treatment by ultrafiltration/diafiltration with a 10 kDa membrane.

2. MATERIALS AND METHODS

2.1 Concentrated deproteinized wheys

Goat's and sheep's Sorelho was supplied by Escola Superior Agrária de Coimbra, the Sorelho was filtered, using a cloth filter in order to separate suspended particle material and then processed at 45-50 ºC using a filtration pilot plant equipped with an organic Parker™ membrane (SD3838 BS 03S, 6.3 m^2) and a 10 kDa cuttof. After the first concentration step, the diluted retentate (volumetric concentration factor (VCF) of 20.225L of water were added to the 25 L of retentate) was submitted to second concentration step using the same membrane Finally, the diafiltered retentate was submitted to reverse osmosis using a pilot plant equipment equipped with a membrane Seawater model 2.5 S using a VCF of 5. The final concentrated retentate was freeze dried.

2.2 Nutritional Composition

Total protein content was determined via Kjeldahl method (IDF, 1985). Total ashes were determined according to the standard international method (ISO 2171:2004). The lactose concentration in samples was determined by HPLC (Beckman Coulter System Gold HPLC) equipped with a refractometer (Knauer, Berlin, Germany), using a Ultrahydrogel 250 coupled to an Ultrahydrogel 120 columns (Waters, Milford, USA). All analysis were performed in duplicate.

2.3 Fatty Acids

Fatty acid qualitative and quantitative profiles were determined according to Pimentel et al. [3]. All analysis were performed in duplicate.

2.4 Total Amino Acids

The total amino acid determination was performed through HPLC (HPLC Gold 128 Solvent module, Beckman Coulter, USA) with a High-Resolution Fluorescence Detector (Waters 474, USA) and an autosampler (model 410 Varian prostar, Agilent technologies, USA) according to Pripis-Nicolau et al. [4]. All analysis were performed in duplicate.

3. RESULTS AND DISCUSSION

3.2 Nutritional Composition

In Table 1 it is possible to observe the nutritional compositional of goat and sheep Sorelho. The composition of goat sample showed to be 58±0.96 to protein, 1.7±0.056 ashes and 0.93±0.19 lactose (%), and the composition of sheep samples showed to be 75±2.4 to protein, 3.9±0.28 ashes and 69±1.1 lactose (%). The processing (ultrafiltration/diafiltration) applied

to goat and sheep second cheese whey allowed to obtain two protein concentrates with minerals (lower level in goat sample) and lactose demonstrating a potential nutritional value.

3.3 Fatty Acids

The fatty acids profile of the samples was analysed for short-chain fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA). In the literature there are no previous studies describing the fatty acid profile of goat and sheep concentrated second cheese whey, so no comparisons can be drawn. Nevertheless, is interesting to note that although both samples analysed presented a profile rich in fatty acids, goat's sample showed the richest profile, as it presented higher concentrations than sheep's sample.

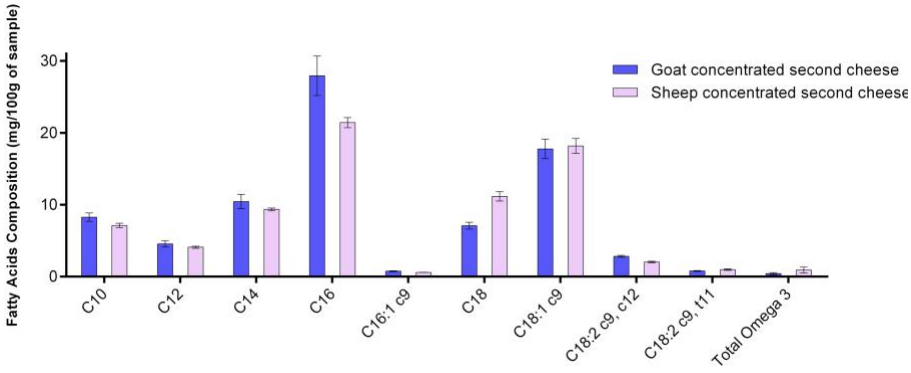

Figure 1. Free fatty acids profile of the goat and sheep samples analysed. All results correspond to an average of all samples analysed for sheep and goat. Results in mg/100g of sample.

The most prevalent fatty acids in the samples of goat and sheep concentrated second cheese whey are depicted in **Figure 1**. The palmitoleic acid (C16:1c9), oleic acid (C18:1c9) are the most relevant MUFA acids. It was also possible to detect the presence of PUFA acids such as rumenic acid (C18:2c9t11), EPA, DHA and α – linolenic acid (C18:3c9c12c15), although both were detected in low concentrations.

3.4 Total Amino Acids

The free amino acid profile present in both goat and sheep concentrated second cheese whey are presented in **Figure 2**.

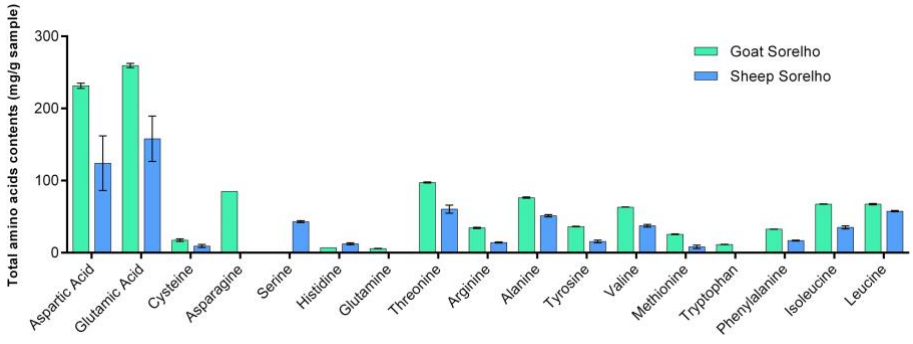

Figure 2. Free amino acids content of the goat and sheep concentrated second cheese wheys.

Goat concentrated second cheese whey revealed the highest concentrations of free amino acids. Aspartic and glutamic acids were those found in higher concentrations in both cases. We can also observe that the amino acids asparagine, glutamine and tryptophan were only present on goat concentrated second cheese whey, unlike the amino acid serine, which was only detected and quantified in sheep concentrated second cheese whey.

4. CONCLUSION

The application of membrane processing (ultrafiltration/diafiltration) to goat and sheep second cheese whey allowed to obtain two innovative ingredients with high nutritional profile with relevant fatty acid and free amino acid profiles. Their application in different matrices may be sought to develop innovative functional foods.

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