sciendo

ASN, Vol 6, No 2, Pages 123 – 129, 2019

Acta Scientifica Naturalis

Former Annual of Konstantin Preslavsky University – Chemistry, Physics, Biology, Geography

Journal homepage: asn.shu.bg

Influence of biological removal of lactose on the physical and chemical parameters of crude sweet whey

Kamel ACEM[1*], Tassadit SAADI[2], Nouria BENALI[3]

[1]*Laboratory of Plant Physiology Applied to Soilless Crops, Faculty of Nature and Life Sciences, University Ibn Khaldoun, BP 78, 14000 Tiaret, Algeria.*

[2,3]*Faculty of Nature and Life Sciences, University Ibn Khaldoun, BP 78, 14000 Tiaret, Algeria.*

Abstract: *The crude sweet whey is an effluent and a co-product of cooked and pressed cheeses and casein, released into the environment without prior treatment (case of Cheese Dairy Sidi Saada, Yellel, Relizane, Algeria) affect the quality of freshwater ecosystems (Oued Mina, Relizane, Algeria).Our study focused on the control of the physical and chemical parameters of crude sweet whey and delactosed whey.The results showed that the applied bioprocess modified the physical and chemical parameters of crude sweet whey such as :density,dry matter,refractive index,viscosity,ash,pH and electrical conductivity, acidity,proteins and lactose; for this purpose these findings depended on the operating conditions, and the composition of the whey put in treatment.*

Keywords: Crude sweet whey, bioprocess, lactic ferment, lactose, environment.

Introduction

The whey by its various origins is defined as the liquid residue from the production of cheese and casein ; the crude sweet whey is an effluent from cooked and presse cheeses and casein noted by Panesar et al. [18]. According to Baldasso et al. [4], the whey is a highly polluting by-product of cheese and casein powder manufacturing with worldwide production of whey is estimated at around 190×10^6 ton/year and

Corresponding author: kamel_acem@yahoo.fr

DOI: 10.2478/asn-2019-0023

growing. Lactose, the largest constituent of whey (70%-72% of the total solids), is the main component causing these high values for BOD and COD [9,12]. It has a very high Biochemical Oxygen Demand (BOD) that can vary from 40000-60000 mg/l and a very high Chemical Oxygen Demand (COD) of between 50000-80000 mg/l [8]. According to the works of Acem et al. [2], the latter may be a favorable factor in the biological pollution of freshwater ecosystems following its native biochemical composition. In this context, and to solve this problem, our study focuses on the application of a biological method to minimize the pollutant potency of crude sweet whey.

Material and Methods

Crude sweet whey and delactosed whey

The crude sweet whey is prepared at the laboratory level using a skim milk powder (0% Fat) made from cow's milk by FONTERRA Ltd, 9 Princes Street, Auckland, New Zealand [1], adding 2 volumes of rennet 1%, and heated to 35°C/40 min [20] ; filtered by filter paper (German Folded Filters : 185 mm diameter) and stored at 4 °C [1]. The delactosed whey is carried out according to the protocol published by [1].

Physical and chemical parameters

The physical parameters analyzed on the two types of whey are : pH (pH meter CG 822 GHS), ash [3], electrical conductivity (EC) by conductivity meter (PHYWE 13701.93), dry matter AFNOR method [1], refractive index (refractometer : RL2, Nr 4711), viscosity (viscometer : HOEPPLER BH2), density (pycnometer), and the chemical parameters controlled on both types of whey are : acidity [15], proteins by Lowry et al.[14], and lactose [16].The experimental data are analyzed statistically by R software.

Results and Discussion

Physical parameters

The figures 1a and 1b show the physical parameters analyzed on crude sweet whey(CSW) and delactosed whey(DW).

Corresponding author: kamel_acem@yahoo.fr

DOI: 10.2478/asn-2019-0023

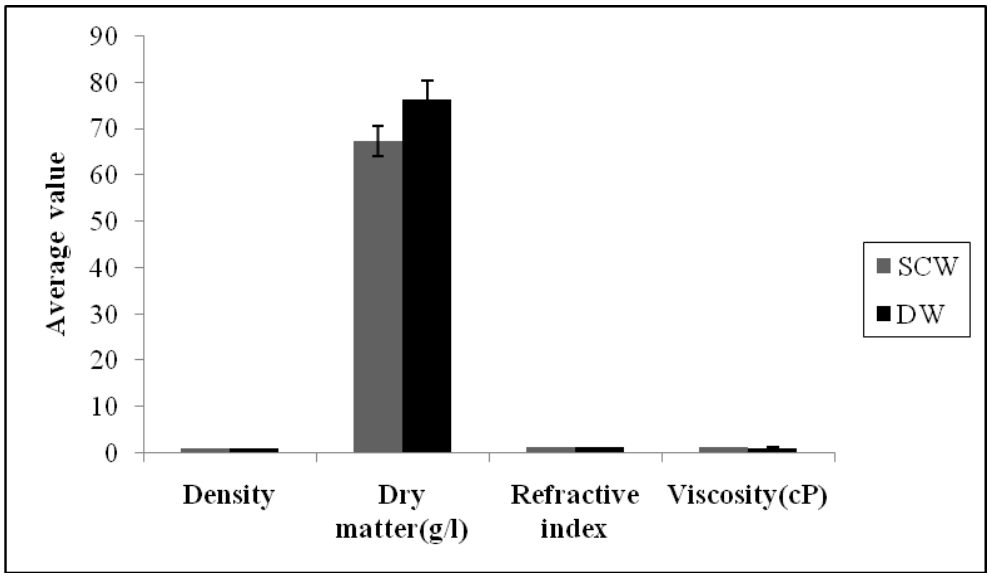

Fig.1a.Physical parameters analyzed on crude sweet whey(CSW) and delactosed whey(DW).

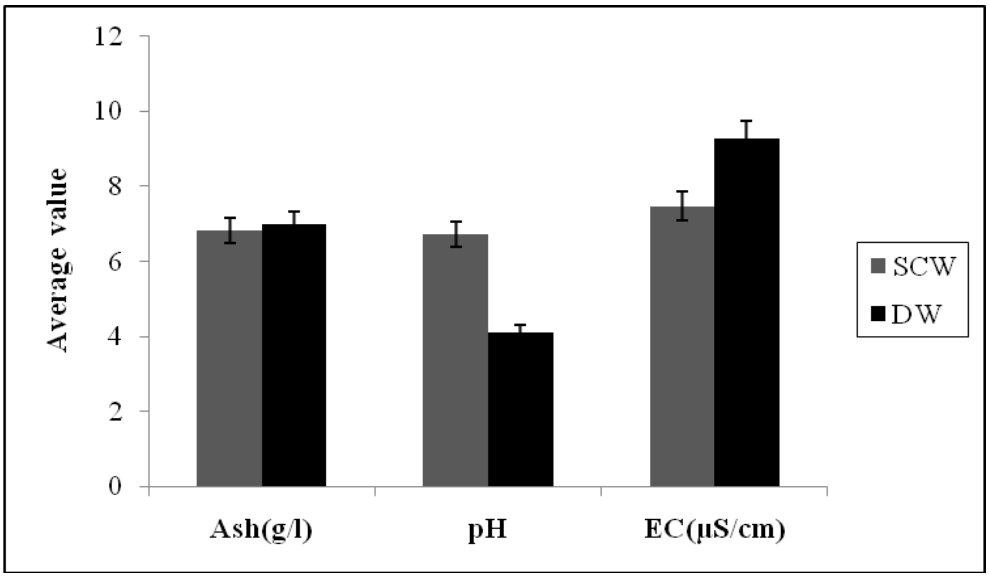

Fig.1b.Physical parameters analyzed on crude sweet whey(CSW) and delactosed whey(DW).

a variability was recorded for the physical parameters of both types of whey (figure 1a and 1b): density at 25°C (CSW: 1.031, DW: 1.0275), dry matter (CSW: 67.343g/l, DW: 76.44g/1), refractive index at 25°C(CSW: 1.3438,DW: 1.3460), viscosity at 25°C (CSW: 1.323cP, DW: 1.204cP), the same remark was

Corresponding author: kamel_acem@yahoo.fr

DOI: 10.2478/asn-2019-0023

observed for figure 1b, namely: ash (CSW: 6.82g/l, DW: 6.98g/l), pH at 25°C (CSW: 6.72, DW: 4.1), electrical conductivity(EC) at 25 °C (CSW: 7.47µS/cm, DW: 9.28µS/cm).

Chemical parameters

The figure2 shows the variation of chemical parameters in both types of whey: acidity (CSW:11.8°D, DW:87.3°D), proteins (CSW:10.8g/l, DW:11g/l) and lactose(CSW:48.42g/l,DW:18.68g/l).The results found are comparable to those noted in the works of [1] for the two types of whey .

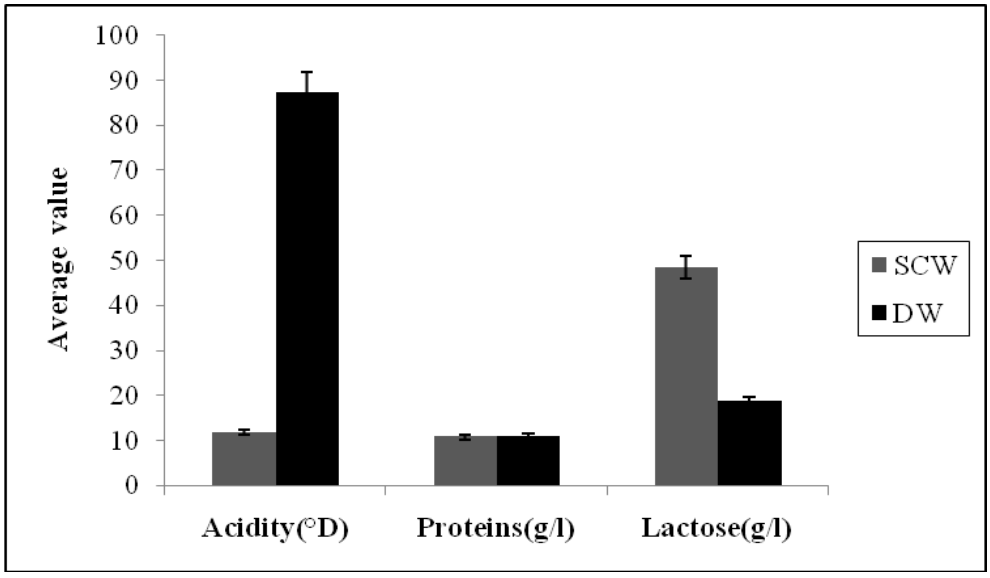

Fig. 2. Chemical parameters analyzed on crude sweet whey (CSW) and delactosed whey(DW).

The whey contains about 50% of milk solids, including almost 100% of the lactose and 20% of the total proteins [5]. The variability in the value of the electrical conductivity is mainly due to the mineral composition and the ionic strength of the whey [19].According to Adrian et al.[11], the viscosity depends on the temperature, the nature of the solvent, the size, the shape, the concentration, the electrical charge of the dispersed particles and their affinity for the solvent. According to Lorient et al.[13], the viscosity of most proteins increases in an alkaline medium. According to [6], the density depends on the content of dry matter, fat and temperature.

Corresponding author: kamel_acem@yahoo.fr

DOI: 10.2478/asn-2019-0023

The main fermentation used in food microbiology is the thermophilic lactic fermentation in which lactic acid is produced from lactose, for this reason we have used a yoghurt strain which is composed by means of a special leaven in which there is two bacteria *St. thermophilus* and *L. bulgaricus* [1]; during the parallel growth of these organisms, lactic acid is produced by Streptococci and aromatic compounds are formed by Lactobacilli. pH is a decreasing function with acidity, the latter evolves with the composition and the high content of substances acids [15]; according to [17], thermophilic ferments are less sensitive to pH than mesophiles: *Streptococcus thermophillus* and *Lactobacillus bulgaricus* develop in milk respectively up to pH 4.1 and 3.8; and according to [10], their ability to grow at temperatures above 40°C, with optimum growth between 40 and 50°C.

we note that the lactose content expressed per g/l in crude sweet whey is higher than that found in delactosed whey; this decrease in lactose is probably related to the number of lactic acid bacteria that bioconversion of this substrate (microbial activity) into lactic acid, the production of lactic acid by microorganisms is due to the richness of media in metal ion [7].The protein content of delactosed whey is very similar to that of crude sweet whey; according to [1], these variations are probably related to the proliferation of the native and exogenous microbial load (bacterial growth of the seeded thermophilic strain) until a slowing down of growth by the inhibitory action of lactic acid secreted in the middle.

Conclusion

With a view to reducing the pollutant load (lactose) of crude sweet whey, the present work has shown that the use of lactic acid bacteria (lactic ferment) as a means of reinforcing the removal of lactose for crude sweet whey has given satisfactory results, mainly reflected by the reduction of the lactose content estimated at 38.58% (from 48.42g/l in the CSW to 18.68g/l in the DW); this bioprocess thus generated a general variation concerning the other physical and chemical parameters, notably a notable decrease in pH (from 6.72 in the CSW to 4.1 in the DW) and a remarkable increase in the lactic acid content (from 11.8 °D in the CSW at 87.3 °D in the DW).

Abbreviations

BOD :Biochemical oxygen demand.

COD :Chemical oxygen demand.

EC :Electrical conductivity.

CSW : Crude sweet whey.

Corresponding author: kamel_acem@yahoo.fr

DOI: 10.2478/asn-2019-0023

DW : Delactosed whey.

References

[1]. Acem, K.;Choukri, A., "Study of the emulsifying properties of whey proteins in crude and modified environments", *J Appl Sci Res*,**2012**, *8*(7), 3293-3303.

[2]. Acem, K. ; Mechouar, M. ; Ayad, I. ;Mettai, K. ;Kadi, S. ;Fetouhi, B., "Impact du lactosérum doux brut sur les propriétés physiques et chimiques des écosystèmes dulçaquicoles", Conférence scientifique internationale sur l'environnement et l'agriculture(CSIEA), **2017**, Hammamet, Tunisie, 24 au 25 Avril.

[3]. AFNOR., Méthodes d'analyses du lait et ses produits laitiers, recueil de normalisation française, 2ème édition, **1980**, p580.

[4]. Baldasso, C. ; Barros, T.C. ; Tessaro, I.C., "Concentration and purification of whey proteins by ultrafiltration", *Desalination*, **2011**, *278*, 381-386.

[5]. Bansal, N. ; Bhandari, B., "Functional milk proteins : Production and utilization-whey-based ingredients", In : McSweeney, P.L.H. ; O'Mahony, J.A., (Eds.), *Advanced dairy chemistry*, **2016**, Springer, New York, USA, 67-98.

[6]. Boudier, J.F. ; Luquet, F., "Utilisation de lactosérum en alimentation humaine et animale, Série synthèse bibliographique", APRIA, Paris, **1980**, *21*, 96.

[7]. Boy Aval, P., "Lactic acid bacteria and metal ions", *le lait*, **1989**, *69*, 87-113.

[8]. Chatzipaschali, A.A. ; Stamatis, A.G., « Biotechnological utilization with a focus on anaerobic treatment of cheese whey: current status and prospects", *Energies* , **2012**, *5*, 3492-3525.

[9]. Patel, S.R. ; Murthy, Z.V.P., "Waste valorization: Recovery of lactose from partially deproteinated whey by using acetone as anti-solvent", *Dairy Science & Technology*, **2011**, *91*, 53-63.

[10]. Eck, A. ; Gillis, J-C., "Le fromage : De la science à l'assurance-qualité", Tec et Doc, Lavoisier, Paris, **1997**, p891.

[11]. Adrian, J.; Legrand, G. ; Franrue, R., "Dictionnaire de biochimie alimentaire et de nutrition", Tec et Doc, Lavoisier, Paris, **1981**, p233.

[12]. Jelen, P. , "Whey based functional beverages", In : Paquin P (ed) Functional and Speciality Beverage Technology. Woodhead Publishing, Cambridge, UK, **2009**, 259-279.

[13]. Lorient, D. ; Luquet, J. ; Cheftel, J. C., "Protéines alimentaires", Tec et Doc, Lavoisier, Paris, **1985**, p309.

[14]. Lowry, O.H.; Rosebrough, N.J.; Farr, A.L.; Randall, R.J.,"Protein measurement with the Folin phenol reagent", *J. Biol. Chem*, **1951**, *193*, 265-275.

[15]. Mathieu, J., « Initiation à la physicochimie du lait", Tec et Doc, Lavoisier, Paris, **1998**, p220.

Corresponding author: kamel_acem@yahoo.fr

DOI: 10.2478/asn-2019-0023

[16]. Miller, G.L., « Use of dinitrosalycilic acid reagent for determination of reducing sugars", *Anal chem*, **1959**, *31*, 426-428.

[17]. Multon, J.L., « Microbiologie industrielle : Les micro-organismes d'intérêt industriel", Tec et Doc, Lavoisier, Tome 1, Paris, **1993**, 171-215.

[18]. Panesar, P.S. ; Kennedy, J.F. ; Gandhi, D.N. ; Bunko, K., "Bioutilisation of whey for lactic acid production", *Food Chemistry*, **2007**, *105*, 1-14.

[19]. Tardat-Henry, M. ; Beaudry, J. P., "Chimie des eaux, éditions le Griffon d'argile", Sainte-Foy (Québec), Canada, **1992**, p537.

[20]. Baumy, J.J.; Brule, G., "Étude comparée de la solubilité et de la viscosité des solutions de caseinates et paracaseinates de sodium en présence de calcium", *le lait*, **1986**, *66*, 65-77.

Corresponding author: kamel_acem@yahoo.fr

DOI: 10.2478/asn-2019-0023