https://repository.uaeh.edu.mx/revistas/index.php/icap/issue/archive

Boletín de Ciencias Agropecuarias del ICAP

Publicación semestral, Vol. 6, No. 12 (2020) 15-17

ICAP

ISSN: 2448-5357

Uses and properties of whey

Usos y propiedades del Lactosuero

Jonathan Hernández-Miranda [a], Sergio Soto-Simental [b], Aurora Quintero-Lira [b], Javier Piloni-Martini [b]

Abstract:

Whey is a by-product of the dairy industry, which has a high nutritional value due to the presence of protein, lactose, vitamins and minerals that have nutritional functions of interest. Whey can be use directly as an ingredient in various products or it can be fractioned into its different components to be use for various purposes, thus given added value to this by-product, however the lack of information about is use has led producers to end up for discarding it, thus losing value nutritional components. Therefore this research offers a brief review of the uses and properties of whey.

Keywords:

Whey, whey protein, lactose, minerals, achievement, properties

Resumen:

El lactosuero es un subproducto de la industria láctea, el cual posee un alto valor nutritivo por la presencia de proteínas, lactosa, vitaminas y minerales que tienen funciones biológicas de interés. El lactosuero puede ser utilizado directamente como ingrediente en diversos productos o puede ser fraccionado en sus diferentes componentes, para utilizarlos con diversos objetivos, dando así un valor agregado a este subproducto, sin embargo la falta de información acerca de su aprovechamiento ha generado que productores terminen por desecharlo perdiendo con ello valiosos componentes nutritivos. Por lo cual la presente investigación ofrece una breve revisión de los usos y propiedades del lactosuero.

Palabras Clave:

Lactosuero, proteínas de lactosuero, lactosa, minerales, propiedades

Introduction

Whey is a by-product of dairy industry that comes of clotting milk and later casein removal, during cheese manufacturing [1,2,26]. It is categorized in two types of whey, sweet whey and acid whey, that differ in how milk is coagulates. The first is produced from cheeses coagulated whit rennet (Chymosin protease) while the second is obtained from cheeses made by acid precipitation, adjusting pH to 4.6 by the action of lactobacillus, adding organic acids (lactic acid) or mineral acids such as hydrochloric or sulfuric [18,23]. This by-product is considered like a source of compounds of high nutritive valued, chemically contain 93-94% of water [22], that retain approximately the 55% of solids present in whole milk, including whey protein, most of it lactose, minerals like calcium and phosphorus, [12] vitamins soluble in water [3] such as C and vitamins from B complex like thiamine, riboflavin, pantothenic acid, pyridoxine, cobalamin, [4,19] also contain lactic and citric acid, compounds non-protein nitrogens such as urea or uric acid, [14] but this components are modified depending on the type of whey, as a consequence of the manufacturing process. In general acid whey has a low pH, low concentration of protein and lactose, but contains a higher amount of calcium, phosphorus and lactic acid compared to sweet whey. It is known that the manufacture of 1 Kg of cheese produce approximately 9 Kg of whey, making it, the most abundant product, that could be tapped for its nutrimental compounds, offering different ways to give added value. However, the lack of information had generates that sometimes this by-product is discarded without taking advantage of its nutritional value, therefore the principal

[a] Jonathan Hernandez-Miranda, Universidad Autónoma del Estado de Hidalgo, https://orcid.org/0000-0002-6363-3126, Email: he214820@uaeh.edu.mx

[b] Universidad Autónoma del Estado de Hidalgo, https://orcid.org/0000-0002-6923-0926, Email: sotos@uaeh.edu.mx

Fecha de recepción: 30/04/2020, Fecha de aceptación: 30/04/2020, Fecha de publicación: 05/07/2020

aim of this work, is to provide information about of the different ways to advantage whey.

Use of whey

The application of whey can be divided in four basic ways: applying directly in some products, separation and application of whey components, use in biotechnological processing and partial processing whit after use. [25] Therefore, as a consequence of its components, it is use directly in bakery, meat, confectionery, dairy products, flavoured, carbonated, probiotic and alcoholic beverages, increasing the nutritional value or acting as an emulsifier, gelling or foaming agent [9,12,19,22] in addition, the components of whey promote the multiplication of desirable microflora in the intestine tract. [20] As for it fractionation, from whey can be obtained lactose, whey proteins, free amino acids, vitamins and minerals useful to supplement or enrich other food products. The biotechnology industry takes advantage of the high lactose content to produce alcohol and lactic acid [15,21,23] whey has also been used as a culture medium to produce bacteriocins and enzymes, organic chemicals like, acetic, citric, propionic acid and glycerol, bioplastics have been manufactured, [18,23] and biofuels such as bioethanol and bio-hydrogen which are an alternative to fossil fuels. [14,16] Finally the partial processing of whey in cocentrates and isolates of protein is one the main ways to take advange of whey, which has been the subject of scientific research, because is a complete source of proteins that is rich in aminoacids (AA) that containing sulfur and branched chains, [4] are recognized for their high nutrition value, high digestibility, rapid absorption and generation of AA in plasma, [5] these products consist of the main whey proteins, including beta lactoglobulin (β-LG), alpha lactoalbumin (α-LA), bovine serum albumin (BSA), lactoferrin (Lf), immunoglobulins (Ig) and transforming growth factor, [15] these whey derivatives have been used as an ingredients in various food products such as ham, pickles, confectionery, cakes, infant formulas and sport beverages [3] and its used on the one hand is justified by its capacity as an emulsifying or stabilizing agent due to its high content of β-LG, which is the only protein fraction capable of forming fibers that give it this property, [11] together with this, β-LG has shown antihypertensive, anticarcinogenic, hypocholesterol and antimicrobial activity, [24] on the other hand, due to its easy digestion, biological and nutritional properties for health promotion and prevention of diseases, it has been used in manufacture of infant formulas. [6,7,27] These properties can be attributed to the presence of Lf that plays an important role in the chelation of metals and AA that carry free radicals, [13] however, it has been reported that in general the whey proteins present antibacterial, immunomodulatory and anti-inflamatory effects [10] in addition have an effect on the relief of fasting blood glucose and the elevation of body weight, it has been suggested that they may be useful in the management of diabetes. [13]

The AA release through hydrolysis, generating active peptides, is another way to take advantage of whey and the importance of these products, is a consequence of they have shown antioxidant effects by increasing the presence of glutathione (GSH) that reduces hydroperoxides in alcohols and peroxide in water through the oxidation of its reduce form [4] also the AA that make up the whey proteins have different functions in the body, for example, leucine has a key role in the regulation of the protein synthesis machinery [29] minimize the loss of muscle mass, which is attributed to the rapid digestion and absorption of proteins that generate an increase in plasma AA, [8] the AA that containing sulphur such as cysteine and methionine precursors of GSH have shown anticarcinogenic and antioxidant properties additionally improve the immune functions and branched-chain amino acids such as leucine, isoleucine and valine have a crucial role in metabolism, homeostasis of blood glucose and neural functions. [12,17] In conclusion the whey is a by-product whit a high nutritive value and functional properties which has a wide industrial applications, from as an ingredient to increase the nutritional value of some products to being a means of production compounds of industrial interest. It also offers various alternatives for producers to generate economic benefits without loss of raw material.

References

[1] Brandelli A, Joner-Dariot D, Folmer-Correa AP. Whey as a source of peptides with remarkable biological activities. Food Research International. 2015; 73: 149–161.

[2] Campbell RE, Drake MA. Cold enzymatic bleaching of fluid whey. Journal of Dairy Science. 2013; 96: 7404-7413.

[3] Chandrapala J, Duke MC, Gray SR, Zisu B, Weeks M, Palmer M, Vasiljevic T. Properties of acid whey as a function of pH and temperature. Journal of Dairy Science.2015; 98: 4352-4363.

[4] Corrochano AR, Buckin V, Kelly PM, Giblin L. Invited review: Whey proteins as antioxidants and promoters of cellular antioxidant pathways. Journal of Dairy Science. 2018; 101: 4747-4761.

[5] De Moura CS, Lollo PCB, Morato PN, Carneiro EM, Amaya-Farfan J. Whey protein hydrolysate enhances the exercise-induced heat shock protein (HSP70) response in rats. Food Chemistry. 2013; 136: 1350-1357.

[6] Feng X, Li C, Ullah N, Cao J, Lan Y, Ge W, Hackman RM, Li Z, Chen, L. Susceptibility of whey protein isolate to oxidation and changes in

physicochemical, structural, and digestibility characteristics. Journal of Dairy Science. 2015; 98: 7602-7613.

[7] Kelly GM, O'Mahony JA, Kelly AL, O'Callaghan DJ. Effect of hydrolyzed whey protein on surface morphology, water sorption, and glass transition temperature of a model infant formula. Journal of Dairy Science. 2016; 99: 6961-6972.

[8] Kobayashi Y, Somoto Y, Mitsuyama E, Tanaka A, Yuda N, Nakada H, Yamada A, Yamauchi K, Abe F, Nagasawa T. Supplementation of protein-free diet with whey protein hydrolysates prevents skeletal muscle mass loss in rats. Journal of Nutrition & Intermediary Metabolism. 2016; 4: 1-5.

[9] Lollo PCB, Soares MC, Neder MP, Gomes CA, de Freitas CW, Baú BC, Nisishima L, Faria JAF, Maróstica JM, Oliveira FC, Amaya-Farfan J. Probiotic yogurt offers higher immune-protection than probiotic whey beverage. Food Research International. 2013; 54: 118–124.

[10] Ma Y, Liu J, Shi H, Yu, L. Isolation and characterization of anti-inflammatory peptides derived from whey protein. Journal of Dairy Science. 2016; 99: 6902-6912.

[11] Mantovani RA, Furtado GF, Netto FA, Cunha RL. Assessing the potential of whey protein fibril as emulsifier. Journal of Food Engineering.2018; 223: 99-108.

[12] Martins CPC, Ferreira MVS, Esmerino EA, Moraes J, Pimentel TC, Rocha RS, Freitas MQ, Santos JS, Ranadheera CS, Rosa LS, Teodoro AJ, Mathias SP, Silva MC, Raices RSL, Couto SRM, Granato D, Cruz AG. Chemical, sensory, and functional properties of whey-based popsicles manufactured with watermelon juice concentrated at different temperatures. Food Chemistry. 2018; 255: 58-66.

[13] Mohamed RS, Marrez DA, Salem SH, Zaghloul, AH, Ashoush, TS, Farrag, ARH, Abdel-Salam, AM. Hypoglycemic, hypolipidemic and antioxidant effects of green sprouts juice and functional dairy micronutrients against streptozotocin-induced oxidative stress and diabetes in rats. Heliyon. 2019; 5:

[14] Monami D, Aryama R, Sadhan, KG. Supply Chain of Bioethanol Production from Whey: A Review. Procedia Environmental Sciences. 2016; 35: 833-846.

[15] Nguyen DN, Sangild, PT, Li, Y, Bering, SB, Chatterton, DEW. Processing of whey modulates proliferative and immune functions in intestinal epithelial cells. Journal of Dairy Science. 2016; 99: 959-969.

[16] Parashar A, Jin, Y, Mason, B, Chae, M, Bressler, DC. Incorporation of whey permeate, a dairy effluent, in ethanol fermentation to provide a zero waste solution for the dairy industry. Journal of Dairy Science. 2016; 99: 1859-1867.

[17] Patel S. Functional food relevance of whey protein: A review of recent findings and scopes ahead. Journal of Functional Foods. 2015; 19: 308-319.

[18] Pescuma M, Font de Valdez, G, Mozzi, F. Whey-derived valuable products obtained by microbial fermentation. Appl Microbiol Biotechnol. 2015; 99: 6183-6196.

[19] Poveda EE. Whey, generalities and potential use as source of calcium from high bioavailability. Revista Chilena de Nutrición. 2013; 40(4): 397-403.

[20] Rajoria A, Chauhan AK, Kumar J. Studies on formulation of whey protein enriched concentrated tomato juice beverage. Journal of Food Science and Technology. 2015; 52(2): 885–893.

[21] Risner D, Tomasino E, Hughes P, Meunier-Goddik L. Volatile aroma composition of distillates produced from fermented sweet and acid whey. Journal of Dairy Science. 2019; 102: 202-210.

[22] Risner D, Shayevitz A, Haapala K, Meunier-Goddik L, Hughes P. Fermentation and distillation of cheese whey: Carbon dioxide-equivalent emissions and water use in the production of whey spirits and white whiskey. Journal of Dairy Science. 2018; 101: 2963-2973.

[23] Ryan MP, Walsh G. The biotechnological potential of whey. Rev Environ Sci Biotechnol. 2016; 15: 479-498.

[24] Sabokbar N, Khodaiyan F, Moosavi-Nasab M. Optimization of processing conditions to improve antioxidant activities of apple juice and whey based novel beverage fermented by kefir grains. Journal of Food Science and Technology. 2015; 52(6): 3422–3432.

[25] Shershenkov B, Suchkova E. The direct microbial synthesis of complex bioactive compounds as perspective way of milk whey utilization. Energy Procedia. 2015; 72: 317-321.

[26] Smith S, Smith TJ, Drake MA. Short communication: Flavor and flavor stability of cheese, rennet, and acid wheys. Journal of Dairy Science. 2016; 99: 3434-3444.

[27] Tarango-Hernández S, Alarcón-Rojo AD, Robles-Sánchez M, Gutiérrez Méndez N, Rodríguez-Figueroa JC. Short communication: Potential of Fresco-style cheese whey as a source of protein fractions with antioxidant and angiotensin-I-converting enzyme inhibitory activities. Journal of Dairy Science. 2015; 98: 7635-7639.

[28] Turner TL, Kim E, Hwang C, Zhang G, Liu J, Jin Y. Short communication: Conversion of lactose and whey into lactic acid by engineered yeast. Journal of Dairy Science. 2017; 100: 124-128.

[29] Wilkinson DJ, Bukhari SSI, Phillips BE, Limb MC, Cegielski J, Brook MS, Rankin D, Mitchell WK, Kobayashi H, Williams JP, Lund J, Greenhaff PL, Smith K, Atherton PJ. Effects of leucine-enriched essential amino acid and whey protein bolus dosing upon skeletal muscle protein synthesis at rest and after exercise in older women. Clinical Nutrition. 2018; 37: 2011-2021.