Volume : 2 | Issue : 8 | Aug 2013 • ISSN No 2277 - 8160

Research Paper | Biotechnology

Whey - From Waste to Worth

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ABSTRACT

Whey is one of the two proteins in cow's milk which is a by-product during the process of cow's milk being turned into cheese. More than one quarter of the world's whey and lactose products—1.1 million metric tons per year—is manufactured at some 200 whey plants throughout the United States. With an abundance of land and investments in research & development and technology, the U.S. whey industry is capable of unrestrained growth to meet consumer demand. A number of different techniques including ultrafiltration, crystallization, precipitation and reverse osmosis etc. are used to create whey products, but it is time consuming and very costly. There are as such no cheaper and feasible methods to extract whey protein after the thick whey is been extracted for various products. This paper deals with the classification, composition and significance of whey. It also throws some light on the existing methodologies.

KEYWORDS: Whey, Protein blends, Protein isolates, Protein concentrate, ß-lactoglobulin

INTRODUCTION

Whey makes upto 20% of the total protein content. The other protein which is present is casein which is absorbed much slower by the body [1]. The action of rennet on casein during the manufacture of cheese results in the separating of milk into curds and whey. Acid whey is produced from cheeses such as cottage and cream. Sweet whey is from cheeses such as Cheddar and mozzarella [2]. Components like ß-lactoglobulin and α-lactalbumin are other milk proteins which are formed in the mammary epithelial cells. Specific set of whey proteins found in mammary secretions varies with the species, the stage of lactation, the presence of any infection and other factors. The protein, carbohydrates, lactose, minerals, fat and immunoglobulins content in whey can vary. Other whey proteins are the immunoglobulins (antibodies; especially high in colostrum) and serum albumin (a serum protein). Whey proteins also include a long list of enzymes, hormones, growth factors, nutrient transporters, disease resistance factors, and others [3,4].

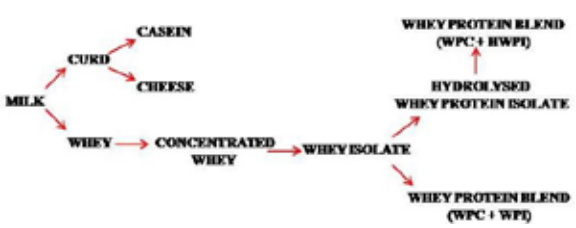

Fig.1. Forms of whey

Whey protein typically comes in two major forms. They are:

a) Whey Protein Concentrate (WPC)

Concentrates have typically a low (but still significant) level of fat and cholesterol but, in general, but they have higher levels of bioactive compounds, and carbohydrates in the form of lactose — they are 29%–89% protein by weight. Even though they have a high biological value, they are cheap [5]. Whey protein concentrates are produced by ultrafiltration (a membrane separation method which is pressure driven and selects on the basis of molecular size) of whey and casein is not present in it. They can be in liquid or dry form and they have an average of 4% moisture. As the protein levels increase, the percentage of lactose decreases. Minerals range from 4 to 7%. WPCs are soluble in water because of the processes used in their manufacture [2]. Most WPCs contain 5-7% milk fat in the dry powdered product. This fat originated in the milk and is not removed by the cream separators through which the whey passes before ultrafiltration. The most modern WPCs use either microfiltration (like ultrafiltration but use membranes with pores sized at about 200 000 Da molecular weight) or ion exchange of the proteins themselves, prior to ultrafiltration, to make a protein product almost devoid of all fat [6].

b) Whey Protein Isolate (WPI)

Isolates are whey in its purest form. They are formed when the protein concentration exceeds 90%. They are processed to remove the fat, and lactose, but are usually lower in bioactivated compounds. Like whey protein concentrates, whey protein isolates are mild to slightly milky in taste. Whey protein isolate powders have the most amount of protein per serving and are generally priced higher than concentrate. The manufacturers refine whey protein isolate using microfilters and ion exchanges to reduce the level of lactose and fat in the product. This may make whey protein isolate an acceptable choice for those who are lactose intolerant.

Whereas, whey supplements comes in other three major types. They are:

a) Pure Whey Isolates (PWI)

Whey isolate powders are more expensive, but they contain the highest amount of protein per serving and have no carbs, lactose, and fat content.

b) Whey Protein hydrolysate (WPH)

Hydrolysates are whey proteins that are predigested and partially hydrolyzed for the purpose of easier metabolizing at a controlled temperature and pH, but their cost is generally higher. Highly-hydrolysed whey may be less allergenic than other forms of whey. Whey protein hydrolysates find uses in high value specialist nutritional applications such as tube-feeding preparations or special dietary supplements. In a hydrolysate, efforts are taken to get all the protein into peptides of two to five amino acids, with few free amino acids and no larger peptides. Interestingly, some peptides released from milk proteins can be biologically active. Some can transport calcium from the gut into the blood during digestion and some can inhibit enzymes in the human body involved in excessive blood pressure. Choice of the right enzymes and careful control of the hydrolysis process are required to make the desired hydrolysate product.

c) Whey Protein Blends (WPB)

They are the most popular of the whey protein powders. As the name suggests, these products combine whey protein isolate and concentrate to make a high quality product (with an awesome amino acid profile). They are available in affordable rates [7,8].

CLASSIFICATION OF WHEY

Whey is classified to two types: **Sweet whey** with a pH of about 6.02 to 6.58 and **Acid whey** with a pH of 3.57 to 4.341. Sweet whey is manufactured during the making of rennet types of hard cheese like ched-

dar or Swiss cheese. It has a pH of >5.6, results from rennet-coagulated cheese manufacture. Acid whey (sour whey) is obtained during the making of acid types of cheese such as cottage cheese [9]. Although the composition of each whey type is somewhat different and variable, both sweet and acid whey contain about 0.7% to 0.8% protein on a liquid basis, with whey proteins only representing about 10% to 12% of the total solids of whey. The chart below shows the difference in composition between 100 grams of dried sweet whey and acid whey. Acid whey is richer in amino acids. When whey contains casein, it is called Casein whey, but after the removal of casein, it is known as Cheese whey.

Table 1- Composition of sweet whey and acid whey

COMPOSITION (in gm)	SWEET WHEY	ACID WHEY
Carbohydrate	74.5	73.4
Amino acids	102	109
Protein	12.9	11.7
Lactose	74.4	70.0
Fat	1.1	0.5
Moisture	3.2	3.5
Ash	8.4	10.8

Demineralised means having soluble mineral salts removed (such as inorganic salts alongwith some organic ions like lactates and citrates). A small percentage of utilised whey (less than 5%) is demineralised to produce dry demineralised whey. These include whey protein based infant formulas and other medical and nutritional products that require lactose, special nutritional quality of whey proteins and low mineral content [10].

COMPOSITION OF WHEY

Fig.2. Whey composition

SIGNIFICANCE OF WHEY

Whey is rich in BCAAs or branched chain amino acids [11]. The protein found in whey has a high biological value, which measures the rate at which it is assimilated into the body. It is also soluble and very easy to digest. It contains one of the highest quality proteins available. It contains powerful antioxidants, such as glutathione [12], which suppresses the harmful reactions of free radicals [13]. The protein source also contains leucine, which promotes the growth of muscles and helps reduce body fat stores at the same time [14]. It boosts metabolism [15], reduces lipid peroxidation [16] and increases muscle mass [17]. It also gives support to the immune system.

CONCLUSION

Before the innovation of membrane processing was introduced to the dairy industry, in the late 1960's, whey was truly a waste product of cheese making. Earlier, there was a very little knowledge about whey and its beneficial uses, so it was discarded or dumped into local water bodies, as it was considered to be a waste product. There was no significance for whey until 1980, when two major events occurred which are considered as the stepping stone or pillars in the formation of whey protein [18,19]. The important factors that have driven whey towards further processing are the implementation of the strict ecological laws in order to save the environment, increased cost of dumping, in-depth studies and research to examine and explore the advantages of whey [20], new technologies to separate the proteins in whey and scientific research that has uncovered the wide range of nutritional and biological properties of whey that have ultimately added value to a once wasted product [21]. The various existing methodologies are membrane spectrum, ultra filtration process, gel filtration process, heat precipitation process and precipitation by complexing agents. Procedures for the manufacture of whey protein products are based on known behavior of whey components under defined conditions. Properties that have been exploited commercially include: molecular size differences (Ultrafiltration, gelfiltration), insolubility of protein at high temperature, charge characteristics (demineralization, protein removal by ion exchange) and aggregation by polyphosphates and crystallization of lactose. All these procedures are very tedious and involve lot of labour, high technology and are costly. But if we want to concentrate on the extraction of whey proteins from the dairy waste water and later re-use the waste water effectively, then it is an open challenge [22].

REFERENCES

1. Martial Dangin, Yves Boirie, Christelle Guillet,and Bernard Beaufrère (2002). Influence of the Protein Digestion Rate on Protein Turnover in Young and Elderly Subjects. J. Nutr. 132 (10): 3228S-3233S | 2. Karen E. Smith (2001). Dairy Proteins. Wisconsin Center for Dairy Research and Marketing Board. | 3. Boirie Y, Beaufrere B, Ritz P (2001). Energetic cost of protein turnover in healthy elderly humans. Int J Obes Relat Metab Disord. 25:601-5. | 4. US Dairy Export Council (http://www.usdec.org). | 5. Jay R. Hoffman and Michael J. Falvo (2004). Protein - Which is best?. Journal of Sports Science and Medicine (3): 118–130. | 6. Luhovyy BL, Akhavan T, Anderson GH (2007). Whey proteins in the regulation of food intake and satiety. Journal of the American College of Nutrition 26 (6): 704S–712S. | 7. Foegeding, EA; Davis, JP; Doucet, D; McGuffey, MK (2002). Advances in modifying and understanding whey protein functionality. Trends in Food Science & Technology 13 (5): 151–9. | 8. Lee YH (1992). Food-processing approaches to altering allergenic potential of milk-based formula. J. Pediatr. 121 (5 Pt 2):S47–50. | 9. Alsaed, A. K. and Ahmed, R. (2010). Concentrating and drying of whey and utilization of the produced products in bakery and confectionery. A progress report, Department of Nutrition and Food Technology, Faculty of Agriculture, University of Jordan, Amman, Jordan. | 10. Gupta P.R. (1997). Dairy India. Gupta Publishers, New Delhi. | 11. Rieu I, Balage M, Sornet C, et al. (2007). Increased availability of leucine with leucine-rich whey proteins improves postprandial muscle protein synthesis in aging rats. Nutrition 23 (4): 323–31. | 12. Zavorsky, Kubow, Grey, Riverin, Lands (2007). An open-label dose-response study of lymphocyte glutathione levels in healthy men and women receiving pressurized whey protein isolate supplements. International Journal of Food Sciences and Nutrition 58 (6): 429–36. | 13. Mathew, B. B., Tiwari, A., Jatawa, S. K. (2011). Free Radicals and Antioxidants: A Review. Journal of Pharmacy Research, 4 (12): 4340-4343. | 14. Ha E, Zemel MB (2003). Functional properties of whey, whey components, and essential amino acids: mechanisms underlying health benefits for active people (review). J. Nutr. Biochem. 14 (5): 251–8. | 15. Hoffman, JR; Ratamess, NA; Tranchina, CP; Rashti, SL; Kang, J; Faigenbaum, AD (2009). Effect of protein-supplement timing on strength, power, and body-composition changes in resistance-trained men. International journal of sport nutrition and exercise metabolism. 19 (2): 172–85. | 16. Wadhwa, N; Mathew, BB; Jatawa, SK; Tiwari, A (2012). Lipid peroxidation: Mechanism, models and significance. International Journal of Current Science 3: 29-38. | 17. Candow, DG; Burke, NC; Smith-Palmer, T; Burke, DG (2006). Effect of whey and soy protein supplementation combined with resistance training in young adult. International journal of sport nutrition and exercise metabolism. 16 (3): 233–44. | 18. J.N. de Wit. (2001).Lecturer's handbook on whey and whey products. European Whey products Association, Belgium. | 19. Gosta Bylund . Dairy Processing Handbook. (1995). Tetra Pak Processing Systems AB, S-221 86 Lund, Sweden. | 20. http://www.clenburexin.info | 21. www.geafiltration.com. | 22. Sienkiewicz, T., and C.L. Riedel. (1990). Whey and Whey Utilization, 2nd ed., Verlag Th. Mann, Gelsenkirchen-Buer, Germany. |