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A2 MILK AND ITS IMPORTANCE IN DAIRY PRODUCTION AND GLOBAL MARKET

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Abstract

Hot topic in the dairy industry today is the growing popularity of A2 beta-casein milk among consumers and dairy farmers. Milk consists of water, lactose, fat, milk proteins, minerals and miscellaneous. The main milk proteins are caseins. The main types of caseins are *alpha*-casein, *beta*-casein, *kappa*-casein and moreover, the milk protein contains amino acids, peptides. The A1 and A2 beta casein variants are differ only in one amino acid because of a mutation in the 67th position. In preliminary research, A1 and A2 milk proteins have been shown to behave differently during the digestive process due to an amino acid variation. The A1 β -casein amino acid chain is susceptible to breakdown during normal enzymatic digestion, the peptide it breaks down to is a bioactive opioids; beta-casomorphins (BCM), one of peptides, BCM7 has been widely studied. A2 β -casein's amino acid chain is not as likely to experience this breakdown into BCM7 (Clarke, 2014). This study is a short summary about the previous researches and basic information about A2 milk production. In Hungary, there is a farm with 200 dairy cattle and good genetic background. This dairy farm have started to select and test their animals for A2 milk production.

Key words: A2 milk, BCM7, cattle breeds

Introduction

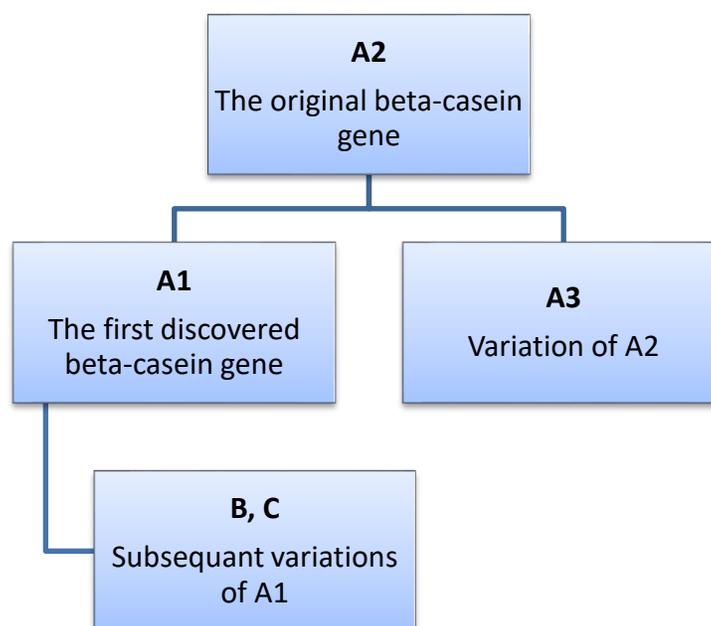
Humans first started to consume milk of other mammals regularly following the domestication of animals. Milk is composed of several solid components including minerals, lactose, fat and protein. There are three notable casein milk proteins: alpha, kappa, and beta-casein (Zoetis, 2015). There are several variants of the beta-casein protein with the most common ones being the recognizable A1 and A2 variants, as well as a B variant and some other rare variants (Pal, 2015).

Altogether we have 15 variants for beta-casein. The most important are shown at *Figure 1*. Research suggests that all cattle carried the A2 variant historically, but the A1 variant arose due to a mutation in European herds a few thousand years ago. *B*-casein is 209 amino acids long. Because of the mutation in the 67 position had changed the proline to histidine created A1 beta-casein. This difference allows



the formation of beta-casomorphin 7 (BCM7) via digestion. Beta-casomorphin 7 (BCM7) is a heptapeptide with opioid characteristics and a strong affinity for mu-opioid receptors (Givens et al., 2013).

Figure 1: Different types of beta-casein milk protein
(Cattel and Nelson, 2010)



The A1 variant is most commonly found in breeds with European ancestry, however, it has been introduced in some non-European cattle populations through crossbreeding (Pal, 2015). In the Holstein population, the A1 and A2 variants are estimated to appear in approximately equal amounts. In Jersey, the A2 allele is slightly more prevalent (Woodford, 2007). Human milk, goat milk, sheep milk and other species are ‘A2-like’ with proline at the equivalent position. Milk in which more than 99% of the beta-casein is the A2 variant is known as ‘A2 milk’. What we can buy in a supermarket is known as A1 (regular or ordinary) milk (Cattel and Nelson, 2010).

Beta-casein protein production is controlled by the combination of any two of A1 and A2 variants as all cows carry two alleles. These alleles are co-dominant, meaning that cows that carry two different variants (heterozygous) will produce equal amounts of each protein that they carry, while cows that carry two copies of the same allele (homozygous) will produce only that protein (Woodford, 2007). This makes achieving a homozygous A2 herd exclusively through genetic selection a possibility for dairy producers (Versteeg, 2016).

Dairy animals possess a genotype expressed as either A1A1, A1A2 or A2A2, with each copy of the beta casein allele leading to the production of the corresponding type of beta casein. A2A2 cows are the only ones that can be considered producers of A2 milk while A1A2 cows will produce milk with a mixture of A1 and A2 beta casein. Genotype of an animal can only be determined via genetic testing. Possible offspring combinations when beta casein genotypes of both parents are known are illustrated in Table 1 (Beavers and Van Doormaal, 2016).



Comparing each cattle species the highest A2 beta-casein rate is in the Guernsey, after that in descending order: Brown Swiss, Ayrshire, Jersey, Milking Shorthorn and Holstein.

Table 1: Possible combinations when mating animals of various beta casein genotypes
(Beavers and Van Doormaal, 2016)

Parent 2	Parent 1			Parent 2	Parent 1			Parent 2	Parent 1		
	A1	A2			A1	A2			A1	A2	
A1	A1A1	A1A2		A2	A1A2	A2A2		A1	A1A1	A1A2	
A1	A1A1	A1A2		A2	A1A2	A2A2		A2	A1A2	A2A2	
50% A1A1 50% A1A2				50% A1A2 50% A2A2				25% A1A1 25% A2A2 50% A1A2			
								100% A1A2			

Historical background of A2 milk

The original evidence implicating A1 beta-casein came from Prof. Bob Elliott from Auckland University. He noted that Samoan children brought up in Samoa had a minimal level of Type 1 diabetes whereas children of Samoan ethnicity in New Zealand are vulnerable. He looked for differences in lifestyle, and identified exposure to cow milk as a possibility. Subsequently working with Dr. Murray Laugesen, he suggested that across the developed world more than 80% of the between-country variations in Type 1 diabetes could be explained by per capita intake of A1 beta-casein (Laugesen and Elliott, 2003). Nevertheless, the background of Type 1 diabetes is not unequivocal. Type 1 diabetes is caused by an autoimmune process, but some different factors, including genetics and some viruses and less known environment factors influences the development of Type 1 diabetes (Kawasaki, 2014). Corran McLachlan showed similar correlations between intake of A1 beta-casein and heart disease.

Some ecological studies have suggested that BCM7 and related compounds may be involved in the aetiology of a range of chronic diseases, including Type 1 diabetes, ischaemic heart disease, autism and schizophrenia. At-risk children and adults are those who, for any of a range of reasons, have a 'leaky gut'. This may be associated with conditions such as stomach ulcers, ulcerative colitis, Crohn's disease and Coeliac disease. Antibiotic treatment and viruses may also affect this permeability (Woodford, 2011). Epidemiological evidence suggests the peptide BCM7 is a risk factor for development of human diseases, including increased risk of Type 1 diabetes and cardiovascular diseases but this has not been thoroughly substantiated by research studies. In addition, BCMs (includes BCM7) may be formed in all fermented dairy products, cheese, and yoghurt, but may be degraded during processing so as not detectable in the product as consumed. So, the different processing factors, such as heat treatment, fermentation, ripening, and cold storage might affect the formation and/or degradation of BCMs (Nguyen et al., 2015).

Present situation of A2 milk on global market

Back in 2000, the a2 Milk Company™ was founded in New Zealand by Dr. Corran McLachlan after the scientific discovery. The a2 Milk Company™ is the biggest Australian owned milk brand. There are 28 certified a2 Milk™ dairy farms that produce pure and natural A2 Milk™



from specially selected cows right across Australia. Each cow on these farms has been selected to produce only the A2 protein. The a2 Milk Company Limited had about 8% market share of the milk products market in Australia in the year 2014 (Adams, 2014) (Figure 2.).

Figure 2: A2 milk products on the market
(Internet1)



In August 2003, ‘The a2 Milk Company’ exclusively licensed patent and trademark rights to US-based Ideasphere Incorporated (ISI) to market a2 Milk products in North America (A2 Corporation, 2004).

The a2 Milk Company’ formed a joint venture with a major British milk supplier, Müller Wiseman Dairies, in November 2011 to process, market and sell its a2 Milk products in Britain and Ireland (Ooi, 2011). In June 2014, ‘The a2 Milk Company’ reported it had 20 dedicated farms supplying milk for processing in the UK (Our farmers, 2014). In its first year, the milk recorded £1 million in sales through 1000 stores.

The first consignments of ,The a2 Milk Company‘ infant formula - a2 Platinum were sent to China in 2013 (Adams, 2014).

The a2 Milk Company’ asked the European Food Safety Authority (EFSA) to undertake a review that A1 milk might be harmful. EFSA report, released in 2009, found that "a cause and effect relationship is not established between the dietary intake of BCM7 (beta-casomorphin-7), related peptides or their possible protein precursors and non-communicable diseases” (EFSA, 2009).

Potential A2 milk producing breeds

Different cattle breeds have different rate of A2 beta-casein in the milk. Comparing some important dairy cattle breeds based on genetic testing, the highest A2 beta-casein rate is in the milk of Guernsey, after that in descending order: Brown Swiss, Ayrshire, Jersey, Milking Shorthorn and Holstein (Woodford, 2011).

Holstein Friesian cattle is known as the world’s highest-producing dairy breed. Holsteins have distinctive markings, usually black and white or red and white in colour. In 2016 (Hungary) the average milking production was 9-10 thousands kg during a lactation with 3.5 – 4 % fat and 2.8 – 3.5 % protein content (Holló et al, 2016). Because of its significant yield, Holstein Friesian



breed is getting more widespread in the World. Although, if you want to produce A2 milk, you should reflect that this breed has the less A2 beta-casein genes but with the highest proceeds (Woodford, 2011).

Jersey cattle is adaptable to a wide range of climatic and geographical condition. Jersey produces more kilogram of milk per kilogram of body weight than any other breed. Jerseys naturally produce the highest quality milk for human consumption. The reason is there is more protein, Calcium and other non-fat solids in its milk compared to other breeds (Béri, 2013). Finally yet importantly, it has a high range of possess A2 beta-casein genes (Kaminski et al, 2007).

We should mention a species that has a fair chance to produce A2 milk and it started to come into general use. The zebu, sometimes known as humped cattle (*Bos indicus*) is a species or subspecies of domestic cattle originating in South Asia. Zebu have humps on the withers, large dewlaps, and droopy ears. They are adapted to the harsh environment of the tropics (Bodnár et al, 2012). Zebu is also used as dairy cattle in spite of *Bos indicus* cows commonly have lower production level then modern cattle breeds.

Findings and conclusions

Farmers in many regions of the world are being incentivised to produce A2 milk to meet the growing demand in what is considered to be a healthier alternative to conventional dairy (Zoetis, 2015). In Hungary, there is a local goal to establish an A2 milk dairy farm in Hajdúdorog. This family farm have 200 producing dairy Holstein Friesian cattle with good genetic background. In this year, they started to test and select their animals for A2 beta casein genes. Helping for the local initiations, we can conclude the potentials and possibilities of producing A2 milk, analysing and summarizing the regional and international market and consumption needs (Table 2.).

Table 2: SWOT analysis of A2 milk production possibilities

Strengths	Weaknesses
<ul style="list-style-type: none"> - health protection - new research area - potential investment - no need of technological changes <ul style="list-style-type: none"> - originality - low market risks 	<ul style="list-style-type: none"> - capital needs - selection costs - special breeds - long term profitability - no additional subventions
Opportunities	Treats
<ul style="list-style-type: none"> - market possibilities <ul style="list-style-type: none"> - higher price - new organizations (research institutes, farms, associations etc.) - spread of information <ul style="list-style-type: none"> - foreign markets - innovation 	<ul style="list-style-type: none"> - no marketing strategy - lack of consumer knowledge <ul style="list-style-type: none"> - no local markets - no outlets - disinterested farmers



Based on the SWOT analysis one can tell that one of the most important question is the marketing strategy and the consumers' needs. Secondly, more information is necessary for the consumers about A2 milk and milk products. Local consumption of A2 milk should be increased by spreading of proper knowledge about the special effects of these products on human health.

Acknowledgements

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