Benefits of consuming A2A2 milk, production chain and standards of good manufacturing practices

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***Abstract* — Milk is one of the most important foodstuffs in the world, ranking among the top five most traded products. In addition to its economic importance as a source of income and livelihood, milk is also a vital source of nutrition. As a complex food containing high concentrations of macro- and micronutrients, milk is important for human nutrition and development. It is a source of high quality protein and provides a significant contribution of calcium, magnesium, selenium, riboflavin, vitamin B12, and pantathenic acid (vitamin B5). Much is being said about foods to improve the digestibility performance and healthiness of the body, in view that the A1 variation milk has effects such as gastrointestinal discomforts, the industry invests in the reintegration of A2 milk.A2A2 milk derives from the genotyping of dairy cattle; there are three possible genotypes being: the A1A1 genotype determines that the animal produces only the β-casein A1; cows with the A2A2 genotype produce only the A2 type; and cows with the A1A2 genotype produce both types. The A2A2 milk has in its composition a difference in the variants of β-casein A1 and A2, in the classification of amino acids, in position 69 of the 209 amino acids that compose the protein, the β-casein A1 presents a histidine residue (His67), whereas the β-casein A2 presents a proline residue (Pro67) in its digestion. Thus, this case study tends to clarify the benefits of A2A2 milk consumption, its ideal and appropriate production chain according to the standards of good manufacturing practices and the effects of its action on the human body.**

Keywords **— A2A2 milk; Beta-Casein; Milk Proteins; Lactose intolerance**

Introduction

Milk is one of the most important agricultural commodities in the world, being among the five most commercialized products both in volume and in value (PLATFORM, 2016). In addition to its economic importance as a source of income and survival for the world's population, milk is also a vital source of nutrition. Because it is a complex food that contains high concentrations of macro and micronutrients, milk is important for human nutrition and development. It is a source of high quality protein and provides a significant contribution of calcium, magnesium, selenium, riboflavin, vitamin B12 and pantothenic acid.

According to Decree 9,013/2017 (BRASIL, 2017): Milk, without further specification, means the product derived from complete and uninterrupted milking, under hygienic conditions, from healthy, well-fed and rested cows. Milk from other animals must be named according to the

species from which it comes. A number of factors, which include economic factors such as income level and relative prices; demographic factors such as urbanization, and sociocultural factors, determines per capita consumption levels of milk, as well as other animal products.

Its average consumption varies according to age, the recommendation for children up to ten years old is 400 mL/day, that is, 146 liters/year of liquid milk or equivalent in the form of derivatives. For young people aged 11 to 19, consumption is higher, 700 mL/day or 256 liters/year and for adults over 20 years old, the recommendation is 600 mL/day or 219 liters/year, including for the elderly , however consumption for this group of people should be mainly skimmed (ZOCCAL, 2021).

According to data from PLATFORM (2016), 816 million tons of milk are produced annually in the world and, on average; each inhabitant per year (WYRZYKOWSKI; REINCKE; HEMME, 2018) consumes 116.5 kg of milk equivalent. In Brazil, according to the IBGE, the survey results for the 1st quarter of 2022 show a 10.3% reduction in the volume of milk purchased compared to the same period of 2021. Compared to the previous quarter, uptake was 8.7 % smaller. Such a scenario is influenced by seasonality issues, as well as by high production costs, which have discouraged production in the field and limited investments in the sector.

Much is said about foods to improve the performance of digestibility and healthiness of the organism, considering that the A1 variation Milk has effects such as gastrointestinal discomforts, the industry currently invests in the reintegration of the A2 variation milk. It is estimated that, initially, the entire bovine population had only the A2 allele and that through evolutionary processes there was a mutation action, providing the emergence of the A1 allele, the authors also point out that CSN2 (the gene that encodes beta- casein) is encoded by genes present in bovine chromosome 6 (CORBUCCI, 2017). A2A2 milk derives from the differentiated genotyping of dairy cattle; there are three possible genotypes: the A1A1 genotype determines that the animal produces only A1 β-casein; cows with the A2A2 genotype produce only the A2 type; and cows with the A1A2 genotype produce both types according to the National Agriculture Confederation. A2A2 milk is called milk that in its composition has a difference in the variants of β-casein A1 and A2, in the classification of amino acids that is in position 69 of the 209 amino acids that make up the protein, β-casein A1 presents a residue of histidine (His67), whereas β-casein A2 has a proline residue (Pro67) in its digestion (BARBOSA et al., 2019).

In this way, the present case study tends to clarify the benefits of consuming A2A2 milk, its ideal and adequate production chain according to the standards of good manufacturing practices and the effects of its action on the human body.

MATERIAL AND METHODS

For the elaboration of the following case study, exploratory reviews were carried out in databases, carried out from June 2021 to November 2022, applying descriptor terms Milk A2A2, Beta-Casein, Milk Proteins, BCM -7, BCM 9, A2 beta-casein, Milk and Opioids. A joint visit

was made to one of the pioneering properties in the production of A2A2 Milk in Brazil, in the municipality of Descalvado in the interior of São Paulo. Seeking to verify conditions of health, nutrition, management, reproduction and production of Milk A2A2.

DISCUSSION

A2A2 Milk is a type of milk from cattle with the A2A2 genotype, this milk is already marketed with indications for consumption for people with a history of gastrointestinal discomfort resulting from the consumption of cow's milk.

According to Decree 9,013/2017, "milk is understood, without further specification, to be the product derived from complete, uninterrupted milking, under hygienic conditions, from healthy, well-fed and rested cows" (BRASIL, 2017). Milk from other animals must be named according to the species from which it comes.

According to Normative Instruction No. 76/2018 (BRASIL, 2018) which regulates the identity and characteristics of refrigerated raw milk, pasteurized milk and type A pasteurized milk, all must meet the following physical-chemical parameters: fat (minimum of 3.0g /100g or 3%), protein (minimum 2.9g/100g or 2.9%), lactose (minimum 4.3g/100g or 4.3%), non-fat solids (minimum 8.4g/ 100g or 8.4%), relative density at 15°C 18 (1.028 to 1.034 g/mL), acidity (0.14 to 0.18g of lactic acid/100mL or 14 to 18°D), cryoscopic index (- 0.530°H to -0.555°H), negative phosphatase test and positive peroxidase test.

Caseins account for about 80% of total milk proteins, and the remaining 20% are composed of whey proteins (globulins and albumin). Among them, we find CSN2, classified as a polymorphism agent, with numerous variations, being differentiated according to different races. The way to identify the genotyping of cows is done through genotypic testing and being certified by Genesis Group through the National Confederation of Agriculture (CNA).

There are three types of possible genotypes: A1A1 determines that the animal produces only A1 β-casein; cows with the A2A2 genotype produce only the A2 type; and cows with the A1A2 genotype produce both types (Confederação Nacional da Agricultura, 2022).

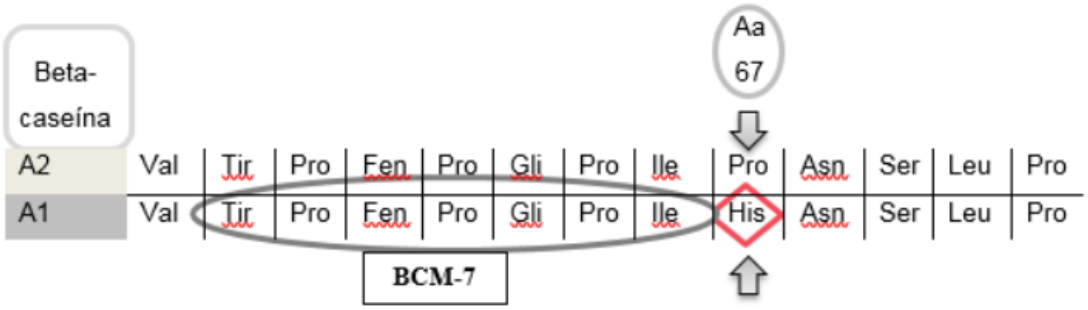
It is estimated that initially, β-casein A2 is the original form of the protein, as it has been present in the cattle herd since its domestication thousands of years ago. The A1 β-casein arose as a result of a transverse genetic mutation, approximately 5,000-10,000 years ago, and spread with the directed reproduction of animals to increase milk production, and with the migration of herds in the process of colonization by man. This is considered a random mutation according to Barbosa, et al. The authors also point out that CSN2 is encoded by genes present on bovine chromosome 6 (CORBUCCI, 2017). In studies already carried out on the A1 and A2 variants of β-casein, variations in gene frequencies (alleles) were described both in breeds commonly used for dairy production and in local breeds. The frequency of the A2 allele is lower in taurine breeds, with the exception of the Guernsey breed (ranging from 0.88 to 0.97), probably due to its

more closed herd and smaller number of animals. The highest frequency (%) of this allele is described in Zebu breeds, as follows: Angus (0.05), Ayrshire (0.28-0.52), Brahan (0.01), Gir (0.88-0, 98), Guzerat (0.97), Hereford (0.20), Dutch (0.25-0.55), Jersey (0.49-0.72), Swiss Brown (0.49-0.72) , Shorthorn (0.51), Simmental (0.56-0.63) and Nordic Red Cows (0.23) (BARBOSA et al., 2019).

There are 13 variations of the betacasein alleles: A1, A2, A3, A4, B, C, D, E, F, H1, H2, I, G, but those in the A1 and A2 group are the most common and frequently encountered forms (MEDEIROS, 2020). In most mammalian species, four different proteins make up the casein group, namely: αS1-casein, αS2-casein, β-casein and κ-casein. In this product, β-casein represents approximately 30% of the total proteins contained and, according to the genetics of the animal, the β-casein A1 and/or A2 variants will be expressed in the milk, originating the denomination A1 milk (in which there will be only β- A1-type casein or a mixture of A1 and A2 β-casein and A2 milk (in which there will only be A2-type β-casein) (BARBOSA et al., 2019). The difference between A1 and A2 β-casein variants It is an amino acid found at position 69 of the 209 amino acids that make up the protein.

According to figure 1, β-casein A1 has a histidine residue (His67), while β-casein A2 has a proline residue (Pro67) (BARBOSA et al., 2019).

Figure 1 - Alterations of the genetic variants, β-caseins A1 and A2, highlighting the differentiation at position 67, responsible for the differential cleavage and release of BCM-7



Source: (BARBOSA et al., 2019)

The action of digestive enzymes on β-casein A1 can release bioactive peptides, such as the opioid peptide BCM-7. According to Lebrun, opioids are chemical substances with activity similar to that of morphines that have activity both in the central nervous system and in peripheral organs, in the gastrointestinal tract they can act by decreasing intestinal motility, increasing water absorption, inhibiting gastric secretion and stimulating the contraction of the gallbladder.

In our organism, the opioid peptide β-casomorphin-7 (BCM-7) can be released during the digestion of β-casein A1, however, in the release during the digestion of β-casein A2, BCM-9 is released. BCM-9 is the peptide available from A2 β-casein, since A1 beta-casein contains histidine at position 67, making this a cleavage point for BCM-7 formation (BARBOSA et al., 2019). This peptide exhibits opioid properties, but with approximately one-quarter the affinity of BCM-7 for ɣ-opioid receptors.

PRODUCTS

Today, food made from A2 milk is already available in supermarket chains, such as 1 liter type A whole milk with nutritional and original properties, 1 liter semi-skimmed milk with 1.5% fat and 1 liter skimmed milk with 0% fat and 0% cholesterol, bottled on the farm itself, easy to digest, being the first A2 type A milk with 5 certifications in Brazil, we also find 600g and 130g natural curds, natural yogurts with only two ingredients and with mild acidity, no sugar, starch, dyes, dyes or stabilizers, fruit yoghurt and curd with pumpkin jam, banana jam and guava without preservatives or stabilizers, 1 liter and 180 g fermented milk, 0% fat and 0% lactose, 1 liter and 550 g fresh cream extremely fresh and 35% fat made 100% A2, coffee with milk to be served chilled and ready to drink, fresh milk sweets with artisanal Argentinian recipe A2A2, no preservatives, cheeses with a smooth and light flavor, keeping eiga with fleur de sel, made with a French recipe, no dyes, stabilizers or preservatives.

GOOD PRACTICES AND SANITY

According to Milk Point magazine, some vaccines are mandatory, a situation defined by official bodies that aim to control and eradicate important diseases for the national and international herd. One of them is Brucellosis, which is mandatory in females from 3 to 8 months old, and its official calendar is defined according to the state in question.

Another mandatory vaccine is against foot-and-mouth disease, a vesicular disease that causes great damage to the well-being of animals, the economy of the property and the health situation of the region in question, and may even affect trade with foreign countries.

The studied property follows a Good Practices manual in addition to carrying out several internal and external controls. It complies with federal legislation and is supervised by the SIF (Federal Inspection Service), in addition to several internal and external audits that take place throughout the year.

A veterinarian provides health care, three times a week, and the main focus is prevention and includes the usual vaccinations, which guarantee a herd free of tuberculosis and brucellosis.

SEALS

EURECICLO - The impact of the eureciclo seal begins with the union of all agents in the recycling chain, including private sorting centers, promoting recycling with social responsibility.

Meanwhile, consumers can recognize and choose companies that invest in and contribute to the conservation of the planet. In addition, it is through this seal that we create and disseminate content that seeks to promote environmental education and awareness for the public (MUNHOZ, 2018).

BDK- BDK- BDK Seal belongs to kosher certification that performs the task of evaluating and certifying food industries. They verify the inputs and their origins, the manufacturing process, as well as the possible influence of other products and production lines within the manufacturing process. Evidenced as a seal on the packaging of industrialized products, the Kosher Certificate is a document issued to attest that the industrial process of a certain company, in a certain production line, obeys the specific norms of the Orthodox Jewish diet (BDK, [n.d.]).

ANIMAL WELFARE - In general, Animal Welfare refers to the state of the individual during his attempts to adjust to the environment. To assess the well-being of the herd, it is necessary to measure different variables that interfere in their lives, such as freedom from thirst, hunger and malnutrition; free from discomfort; free from pain, injury and disease; free to express their normal behavior and free from fear (WQS, 2019).

PROCERT SEAL VERDE - PROCERT - Certification Program for Commitment to Socio-environmental Responsibility is the environmental certification granted to institutions that seek sustainability in all their businesses and that prove to their partners that they apply in their actions, management or products, solutions that encompass the environmental, social and economic environment (INSTITUTO CHICO MENDES, [n.d.]).

Recently, at Embrapa Dairy Cattle (CNPGL) manure management was introduced, in which manure and urine are deposited in tanks for aeration and homogenization, plus water used for automatic cleaning of confinement sheds. After stabilization, this liquid manure (biofertilizer) is used in the culture areas through an irrigation system (CARVALHO et al., 2003b).

In this way, a cycle is closed where the nutrients from the grass feed the cow which provides minerals for the forage through the manure. The studied farm also carries out recycling, with reuse of the sand used in the cows' beds, cleaning of the sheds, decantation, separation of manure by gravity, without the consumption of electricity. In addition, it makes use of rainwater, by capturing rain from the roofs to clean the facilities; it is worth mentioning that the dairy is located next to the milking parlor for the cows and is classified as A. In this way, transport is eliminated from raw milk to industries, a fact that contributes to the reduction of greenhouse gas emissions.

CONCLUSION

Milk is one of the most important foods in the world, being among the 5 most commercialized products, being also a vital source of nutrition and containing high concentrations of macro and micronutrients, milk is important for nutrition and human

development. It is a source of high quality protein and provides a significant contribution of calcium, magnesium, selenium, riboflavin, vitamin B12 and pantothenic acid (vitamin B5).

Milk is understood as the product derived from complete and uninterrupted milking, under hygienic conditions, from healthy, well-fed and rested cows. Your average consumption varies according to age. This study talks about a food to improve the performance of digestibility and healthiness of the organism, considering that the A1 variation milk has effects such as gastrointestinal discomfort.

A2A2 milk is derived from genotyping dairy cattle; there are three possible genotypes: the A1A1 genotype determines that the animal produces only A1 β-casein; cows with the A2A2 genotype produce only the A2 type; and cows with the A1A2 genotype produce both types. A2A2 milk has a difference in its composition in the variants of A1 and A2 β-casein, in the classification of amino acids, A1 β-casein has a histidine residue (His67), whereas A2 β-casein has a proline residue (Pro67) in your digestion.

References

[1] ALVIM, M. J. et al. Sistema de produção de leite com recria de novilhas em sistemas silvipastoris - Fornecimento de concentrado. Disponível em: <https://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Leite/LeiteRecriadeNovilhas/alimentacao.htm>. Acesso em: 30 out. 2022.

[2] BARBOSA, M. G. et al. Leites A1 e A2: revisão sobre seus potenciais efeitos no trato digestório. Segurança Alimentar e Nutricional, v. 26, n. 19, p. e019004, 2019.

[3] BDK. Certificação Kosher - BDK do Brasil. Disponível em: <https://bdk.com.br/quem_somos>. Acesso em: 30 out. 2022.

[4] BRASIL. DECRETO No 9.013, DE 29 DE MARÇO DE 2017. DIÁRIO OFICIAL DA UNIÃO, p. 1–76, 2017.

[5] BRASIL. INSTRUÇÃO NORMATIVA No 76, DE 26 DE NOVEMBRO DE 2018 - Imprensa Nacional. DIÁRIO OFICIAL DA UNIÃO, 2018.

[6] CARVALHO, L. DE A. et al. Sistema de Produção de Leite (Zona da Mata Atlântica) - Alimentação de vacas em lactação. EMBRAPA, p. Embrapa Gado de Leite, 2003a.

[7] CARVALHO, L. DE A. et al. Sistema de Produção de Leite (Zona da Mata Atlântica) - Fatores que afetam a escolha das instalações. Disponível em: <https://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Leite/LeiteZonadaMataAtlantica/infra2.html>. Acesso em: 30 out. 2022b.

[8] CECCHIN, D. Comportamento de vacas leiteiras confinadas em free-stall com camas de areia e borracha. UFLA, p. 114, 2012.

[9] CORBUCCI, F. S. Beta-caseína A2 como um diferencial na qualidade do leite. FMVA-UNESP, p. 23, 2017.

[10] FREU, G.; SANTOS, M. V. Uso de areia reciclada na cama de vacas leiteiras. Disponível em: <https://www.milkpoint.com.br/colunas/marco-veiga-dos-santos/uso-de-areia-reciclada-na-cama-de-vacas-leiteiras-206426/>. Acesso em: 30 out. 2022.

[11] INSTITUTO CHICO MENDES. PROCERT - Programa de certificação pelo compromisso com a responsabilidade socioambiental. Disponível em: <https://institutochicomendes.org.br/certificacao-ambiental/>. Acesso em: 30 out. 2022.

[12] ITO, K. et al. Associations between herd-level factors and lying behavior of freestall-housed dairy cows. Journal of Dairy Science, v. 97, 2014.

[13] LEAL, L. O. P. Tecnologia avançada na produção de leite. Disponível em: <https://animalbusiness.com.br/producao-animal/pesquisa-e-inovacao/tecnologia-avancada-na-producao-de-leite/>. Acesso em: 30 out. 2022.

[14] MARTINEZ, J. C. Formulação de rações para vacas leiteiras. Disponível em: <https://www.milkpoint.com.br/artigos/producao-de-leite/formulacao-de-racoes-para-vacas-leiteiras-parte-1-66920n.aspx?acao=719fca8e-2c8b-4828-be8c-e97441ed3a50#>. Acesso em: 30 out. 2022.

[15] MEDEIROS, I. P. DA S. Efeito do polimorfismo do gene da beta-caseína na qualidade do leite da raça sindi. UFCG, p. 62, 2020.

[16] MUNHOZ, S. Selo eureciclo: o que é e como funciona essa certificação. Disponível em: <https://blog.eureciclo.com.br/selo-eureciclo-como-funciona/>. Acesso em: 30 out. 2022.

[17] NARDES, S. I. Relatório de estágio curricular supervisionado em medicina veterinária. UNIPAMPA, p. 45, 2016.

[18] PLATFORM, G. D. GLOBAL DAIRY PLATFORM. Global Dairy Platform, p. 20, 2016.

[19] POLYCARPO, R. C.; MARTINEZ, J. C. Cruzamento em gado leiteiro - novidades lácteas. Disponível em: <https://www.milkpoint.com.br/artigos/producao-de-leite/cruzamento-em-gado-leiteiro-novidades-lacteas-38687n.aspx>. Acesso em: 25 out. 2022.

[20] SANT'ANNA, A. C.; COSTA, M. J. R. P. DA; MADUREIRA, A. P. Boas práticas de manejo : conforto vacas em lactação. 1. ed. Jaboticabal: FUNEP, 2014.

[21] WQS, Q. Bem-estar animal: Certificações e Auditorias. Disponível em: <https://wqs.com.br/responsible-supply-chain/animal-welfare-certification-audit?&lang=pt&xtor=sec-1119&matchType=p&kw=selo de bem-estar animal&device=c&loc=9100702&network=g&placement=animal-welfare&campaign=food&serviceType=audit&campaignid=16247478624&ad>. Acesso em: 30 out. 2022.

[22] WYRZYKOWSKI, Ł.; REINCKE, K.; HEMME, T. IFCN Long-term Dairy Outlook. IFCN Dairy Research Centre, p. 5, 2018.

[23] ZOCCAL, R. Estatísticas de Consumo. Disponível em: <https://www.embrapa.br/agencia-de-informacao-tecnologica/criacoes/gado_de_leite/pos-producao/consumo/estatisticas-de-consumo>. Acesso em: 20 out. 2022.