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An Overview of A1 and A2 Milk

Shreya Dubey[1], Sonali Thakur[1] and Shivani Gupta[2]
Ph.D. Scholar, Department of Veterinary Public Health and Epidemiology, College of Veterinary Science and A.H., Anand
M.V.Sc., Department of Veterinary Pharmacology and Toxicology, College of Veterinary Science and A.H., Anand

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Introduction

Milk is the whole, fresh, clean, lacteal secretion obtained by the complete milking of one or more healthy milch animals, excluding that obtained within 15 days prior to or 5 days following calving, or such periods as may be necessary to render the milk virtually colostrum-free, and containing the minimum prescribed percentages of milk fat and milk-solids-not-fat (Guetouache *et al.*, 2014). India leads the world in milk production, accounting for 23% of it. From 146.31 million tonnes in 2014–15, milk output in the nation increased at a compound annual growth rate of roughly 6.2% to reach 209.96 million tonnes in 2020–21.The top 5 milk-producing states are Gujarat (7.6%, 15.9 MMT), Madhya Pradesh (8.6%, 18.0 MMT), Uttar Pradesh (14.9%, 31.4 MMT), and Rajasthan (14.6%, 30.7 MMT) (NDDB, 2020). Food that comes from the cattle family is milk. It contains a variety of nutrients, and the specific nutritional makeup of raw milk varies depending on the species and a number of other factors. Water, fat, protein, lactose, ash, and mineral particles are considered to be the "major" components of milk. Phospholipids, sterols, vitamins, enzymes, pigments, and other "minor" ingredients include these. The three "real" ingredients are lactose, casein, and milk fat. Casein protein, which is present in milk and gives it its white colour, is a type of protein.Casein protein makes up around 80% of cow's milk. Casein protein can also be found in infant formulae, yoghurt, cheese, and a number of dietary supplements in addition to milk.

Tab. 1. Average composition of different milk lactating animals (Galali & Al-Dmoor, 2019).

Lactating animals	Dry Matter %	Lactose %	Protein %	Fat %	Ash %
Cow	13	4.9	3.4	4	0.7
Goat	13.2	4.1	3.4	3.5	0.8

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Sheep	19.3	4.8	5.5	7.2	0.9
Buffalo	17.2	4.8	4.2	7.6	0.8
Camel	10.6	4.0	2.3	3.5	0.7

Casein Protein

About 80% of the proteins in bovine milk are casein proteins, which combine with calcium phosphate to produce casein micelles, which have garnered significant attention for many years. S1 casein, S2 casein, casein, and k casein are the four primary protein subtypes that make up casein micelles. Due to the abundance of propyl residues, these constituent casein proteins lack well-defined secondary and tertiary structure. The percentages of alpha s1, alpha s2, beta (CSN2), and kappa (CSN3) casein are, respectively, 39-46%, 8-11%, 25-35%, and 8-15%. The gene cluster member on chromosome 6 that codes for these four forms of casein is located there. Beta casein is the second-most plentiful protein among the caseins, and it has an excellent nutritional balance of amino acids.Beta-casein has a 24kD molecular weight and contains 209 amino acids. There are a total of 13 known genetic variations of beta casein: A1, A2, A3, A4, B, C, D, E, F, H1, H2, I, and G. Of these, A1 and A2 are the most prevalent; B is the least prevalent, and the others are rare. Because of a single nucleotide variation, the beta casein variants A1 and A2 diverge at amino acid position 67, with histidine (CAT) in A1 milk and proline (CCT) in A2 milk. This polymorphism causes a significant conformational shift in the expressed beta casein protein's secondary structure. The bioactive peptide beta casomorphin 7 (BCM7) is produced by intestinal proteolytic digestion of the A1 type of beta casein (raw/processed milk).Due to an immature digestive system, infants may absorb BCM-7, but adults gather the biological activity locally on the intestinal brush boundary. BCM-7 levels are four times greater in variation A1 beta casein-hydrolyzed milk than in variant A2 milk. A2 beta-casein, which has been generated in large quantities since cows were first domesticated some 10,000 years ago, has no known detrimental consequences on human health. Increase Type-1 diabetes, heart disease, autism, gastrointestinal pain, and other diseases in the customer as a result of inflammation. A2-milk is becoming more and more popular throughout the world as a result. In conclusion, there are differing consequences of A1-milk on human health when compared to A2-milk (Kaskous, 2020).

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Tab. 2. Compositional protein quality in cow's milk according to Barth and Behnke (Barth & Behnke, 1997) with some changes.

Protein components	**Protein subclasses**	**Concentrations (g/kg)**
Caseins	αs1-casein (A, B, C, D, E) αs2-casein (A, B, C, D) β-casein (A1, A2, A3, B, C, D, E, F, G, H1, H2, I) k-casein (A, B) γ-Casein	10.3 2.7 9.6 3.5 0.8
Whey proteins	α-Lactalbumin (A, B, C) β-Lactoglobulin (A, B, C, D, E, F, G) Serum albumin Immunoglobulins (A, G1, G2, M, E) Lactoferrin Transferrin Other minor proteins	1.2 3.4 0.4 0.7 0.1 0.1 0.1
Enzymes	Lysozyme, lactoperoxidase, and 60 others	Traces
Peptide hormone	Prolactin, growth hormone, insulin growth factor (IGF)	Traces
Non-protein-nitrogen	Urea, creatine, creatinine, peptide, uric acid, hippuric, orotic acid, free amino acids, nucleic acids.	1.1

Table 3: Compositional changes in various variants of beta casein protein (Kamiński *et al.*, 2007)

Beta-casein variants	**Change in amino acid at different positions of beta-casein**						
A2	SerP(18)	SerP(35)	Glu(36)	Glu (37)	His (67)	His (106)	Ser (122)

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A3	SerP(18)	SerP(35)	Glu(36)	Glu (37)	His (67)	Gln (106)	Ser (122)
E	SerP(18)	SerP(35)	Lys (36)	Glu (37)	His (67)	His (106)	Ser (122)
D	Lys (18)	SerP(35)	Glu(36)	Glu (37)	His (67)	His (106)	Ser (122)
A1	SerP(18)	SerP(35)	Glu(36)	Glu (37)	Pro (67)	His (106)	Ser (122)
B	SerP(18)	SerP(35)	Glu(36)	Glu (37)	Pro (67)	His (106)	Arg (122)
C	SerP(18)	Ser(35)	Glu(36)	Lys (37)	Pro (67)	His (106)	Ser (122)

Because it is thought to have existed before a mutation led to the development of A1 beta-casein in European cattle (Bos taurus) a few thousand years ago, A2 beta-casein is recognised as the original beta-casein protein. within the last decades. The connection between A1 casein in milk and a variety of human illnesses is a crucial one. According to some epidemiological studies, consuming CSN2-A1 may increase the risk of developing type I diabetes and cardiovascular disease (CVD) in people, whereas consuming CSN2-A2 lowers serum cholesterol and LDL lipid concentrations, which are crucial in the prevention of a variety of vascular diseases in people. There isn't much solid clinical evidence available, though.

Between herds of cattle and between nations, there are variations in the prevalence of the A1 and A2 beta-casein proteins. The majority of cow's milk consumed in Europe (with the exception of France), the United States, Australia, and New Zealand contains the A1 beta-casein type. A2 beta-casein is frequently found in the milk of Jersey and Guernsey breeds. All indigenous breeds of cattle and buffalo are thought to have the A2A2 gene, making all indigenous cattle and buffalo milk A2. By looking at 22 desi breeds, NBAGR has analysed the frequency of A-A2 alleles in Indian breeds and discovered that the A2 allele is 100% present in the five high-yielding milch breeds Red Sindhi, Gir, Rathi, Sahiwal, and Tharparkar.The prevalence of the A2 allele gene was 98 percent in the remaining breeds. In

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order to sell "A2 Milk" as a premium milk product and commercialise genetic testing, a business called A2 Corporation was established in New Zealand in the year 2000. Since 2003, A2 milk has been marketed as a premium brand in New Zealand and Australia, providing a natural option for protein content. Additionally, AMUL offers A2 milk from cows and buffalo.

Conclusion

Farmers, breeders, groups, and the media have been debating whether A2-milk is actually healthier than A1-milk for a number of years. There is only one amino acid difference in beta casein between the two types of milk. Because the A2-milk is thought to be the more natural form, the A1-milk mutation has happened at some time during development. Heart disease, diabetes, autism, baby abrupt death, and gastrointestinal inflammation may all be connected to A1-milk and the peptide BCM-7. Further research is required because the findings are conflicting.

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