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Review article

Indian cow and A2 beta-casein – A scientific perspective on health benefits

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ABSTRACT

The cow has a special place in Hinduism since time immemorial due to the diverse health benefits of its products called *Panchagavya*. Ayurveda has well-described the medicinal benefits of cow milk, curd, ghee, dung and urine in indigestion, microbial infections, hormonal imbalance and neurological disorders. Indian cows are well-known for producing A2 beta-casein protein-containing milk which is useful in hormonal disorders including diabetes, hypertension and dyslipidemia. On the other hand, milk containing A1 genotype of beta-casein has been considered to be harmful to health. Cow milk is proven to be a most nutritious food with the bio-protective effect which contains carotenes, vitamin A, vitamin B complex and vitamin C together with flavones, sterols and phenols. The present manuscript describes a general comparison between A1 and A2 variants of beta-casein based on scientific evidence. In view of the health benefits, the present work mainly emphasizes the conservation and propagation of indigenous Indian cow.

INTRODUCTION

Globally 30% of the world's cattle population of about 1.4 billion exists in India (Robinson et al., 2014). India ranks first in milk production with 165.4 million tonnes of milk in 2016-17, out of those indigenous cattle contribute 11.3% and 9.5% by non-descriptive cattle (BAHS, 2017). There are 43 recognized breeds of cattle in India, in addition to a large number of non-descript cattle. In recent times, several of the indigenous breeds suffered decline mainly due to their becoming uneconomical. Therefore, the government has also started several programmes like Rashtriya Gokul Mission, National Kamdhenu Breeding Centre, Central Herd Registration Scheme, Rashtriya Kamdhenu Aayog, and National Dairy Plan to conserve and improve the breed on scientific line in indigenous cattle.

PANCHAGAVYA

For thousands of years, the cow had a central role in the world economy, life and culture. Particularly in India, cow has sacred significance and also has a key role in agriculture, environment, health, economy and spiritual progress. In Ayurveda, there is a long tradition of using cow products for positive health, pharmaceutical processes and in therapeutics. The products from cow are termed as *Panchagavya* which is a combination product of five ingredients viz. milk, curds, ghee, urine and dung. Further, their integration in traditional Indian systems of medicine has been natural, based on their common *Dravyaguna-vigyan*. In India, the tradition of *Panchagavya* usage is much more in South India and particularly in Tamil Nadu and Kerala (Jithesh, 2013).

Panchagavya products have been claimed to be beneficial in curing several human ailments, enhancing immunity and providing resistance to fight infections (Dhama et al., 2005). Therefore, the potential applications of *Panchagavya* as antimicrobial, immunity-booster, antidiabetic, anticancer, anticonvulsant, aphrodisiac, blood purifier, and as a suitable medium to deliver medicines, have caught the attention of scientists and medical professionals (Dhama et al., 2014).

The Prophylactic potential of a *Panchagavya* formulation against certain pathogenic bacteria has been proved (Patel et al., 2018). Similarly, Achliya et al. (2013) reported the protective effects of *Panchagavya* in CCl_4-induced hepatotoxicity. This suggests the rationale of its use in jaundice as per *Charak Samhita.* Many such products of *Panchagavya* are investigated having applications in veterinary sciences and agronomy (Tharmaraj et al., 2011). Pathak has described the bio-

enhancing effects of *Panchagavya* and other cow products in horticulture (Pathak and Ram, 2013). They have described a fermentation product that is said to be stable for 6 months. De et al. (2015) have shown antioxidant activity of *Panchagavya* in DPPH and FRAP assays (Naria et al., 2012). There are already five patents which have been granted on the antibiotic effect of cow urine distillate, bio-enhancer of anti-infective and anti-cancer activities, nutrients in urine distillate, synergistic bioinoculant composition which comprising bacterial strains, synergistic fermented plant growth-promoting biocontrol composition with cow urine and protecting and/or repairing DNA from oxidative damages.

Cow dung

Cow dung has been considered as a gold mine due its wide applications in fuel, gobar gas plants, fertilizer, organic farming, seed protector, floor coating, mudbrick additive, smoke producer, heat source, pot cleaner, pond pH balancer, purifier, pest control, environment protection and in therapeutic uses like skin tonic and tooth polish. Recently, Central Government launched the first cow dung paint, called *Khadi Prakritik Paint*, is a first-of-its-kind product which is being touted as eco-friendly and non-toxic, with anti-fungal and anti-bacterial properties. With actual cow dung as its main ingredient, the paint is said to be cost-effective and also odourless. It has also been certified by the Bureau of Indian Standards (The Indian Express, 2021).

Cow urine

Cow urine has many beneficial properties particularly in the areas of agriculture and therapeutics. Cow urine has been described in '*Sushruta Samhita*' and '*Ashtanga Sangraha*' to be the most effective substance/secretion of animal origin with innumerable therapeutic values. Cow urine contains 24 types of salts and the medicines made from cow urine are used to cure several diseases. Cow urine contents are water 95%, urea 2.5%, minerals, salt, hormones, and enzymes 2.5%. It contains iron, calcium, phosphorus, salts, carbonic acid, potash, nitrogen, ammonia, manganese, iron, sulphur, phosphates, potassium, urea, uric acid, amino acids, enzymes, cytokine and lactose etc. (Bhadauria, 2002). It has also been observed during the scientific research that the urine of Indian cows is highly effective in various health problems.

A number of research activities showed that cow urine enhances the immune system by activating macrophage and their antibacterial activity. There are 752 compounds found through Gas Chromatography-Mass Spectrometry (GC-MS) study in cow urine having immense medicinal value. The cow urine has been found to have used in Agriculture, Biopesticides, Electricity and Kitchen fuel. Urine has therapeutic value in Skin, Stomach, kidney and heart diseases. The urine is also useful in the management of Stones, Diabetes, Liver problems, Jaundice, Athletes feet and serve as an immunostimulant, Anticonvulsant agent, Bioenhancer and anti-cancerous agent. In this direction, nearly 300-litre cow urine of other breeds is now supplied every month to Patanjali in Haridwar at the rate of Rs 25 per litre (Hindustan Times, 2018).

Cow curd

Cow curd (*Dahi*) or *Matha* (whey or buttermilk) prepared from the indigenous cow is milk is considered as digestive, nutritive and useful in gastrointestinal ailments by checking or controlling the growth of the harmful organism. Whey/ buttermilk is very low in fat but has a large number of beneficial bacteria or their breakthrough products in the form of amino acids, peptides, vitamins, minerals etc., which are nutritionally useful in human and animal health. These bacteria attach on the intestinal surface and further multiply there. *Lactobacillus acidophilus* bacteria play a vital role, making the whey more useful. It has been exploited as probiotic to control animal diseases by improving in intestinal microbial balance which rises to hope to control infections in a non-drug manner.

Cow ghee

Cow *ghee* (butter-fat) is traditionally believed to improve memory, voice, vision, intelligence, immunity and anti-cholesterol activity. Cow ghee is helpful for eyesight, wound healing and improves digestion. Modern doctors recommend not using any fat except cow *ghee* to cholesterol patients. The use of cow *ghee* does not increase cholesterol and has no bad effect on the heart. It is helpful in the prevention and control of paralysis and asthma. The ghee obtained from cow milk is very much useful for persons having weak eyesight. Cow ghee used in fire sacrifice produces oxygen. When cow *ghee* is burned with rice, it produces ethylene oxide, propylene oxide, ethylene oxide and formaldehyde, which give immunity against bacteria, which are used in operation theatre (Fulzele et al., 2001; Fulzele et al., 2003). Cow ghee demonstrated the immunostimulant potential as indicated by an increase in neutrophil adhesion, haemagglutination (HA) titre and delayed-type hypersensitivity (DTH) responses in rats. *Ghee* is a product unique to India. It has been reported that the high content of saturated fatty acids in *Ghee* is a possible factor for dyslipidemia and cardiovascular diseases and hence, the consumption of Ghee in excess may cause coronary heart disease (Singh et al., 1996). However, the problem is not necessarily due to only saturated fatty acids, rather, various other factors are also responsible (Malhotra et al., 2017). In experimental animals, conjugated linoleic acid in ghee increased antioxidant activity and prevented atherogenesis (Chinnadurai et al., 2013). Joshi (2014) has demonstrated that *ghrita* prepared by traditional Ayurvedic method contains a higher amount of DHA which has beneficial effects on human health.

Cow milk

According to Hindu mythology as well as the Indian traditional medical practices (both the classical systems like Ayurveda and Siddha and the oral practices of the rural villagers) cow milk has rejuvenation health-protecting and health-promoting properties and hence has been said as the best one among vitalizes. Cow milk is popular in mankind for its nutritive and medicinal values. The literature is available on cow milk in ancient Vedas.

The 10 properties of cow milk were explored by Maharishi Charaka in 200 B.C., which includes *Svadu, Sheeta, Mridu, Snigdha, Bahula, Shlakshna, Pichcchil, Guru, Manda,* and *Prasanna Dashaguna.* That means cow milk has 10 properties i.e. sweet, cold, soft, oily, dense, smooth, viscous, heavy, slow and pleasant. Cow milk is used in conjunction with medicines to enhance their pharmacokinetic and dynamic benefits. In Ayurveda milk is essential for tissue regeneration as it contains many beneficial proteins, hormones, growth factors, vitamins and minerals (De et al., 2015). The cow milk is a healthy food because of low calorie, low cholesterol and high micro-nutrients/vitamins. Compared to buffalo milk it has high moisture, carotene, thiamine, riboflavin, vitamin C, sodium potassium; and on other hand is low in protein, energy (kilocalories), calcium, phosphorous, fat and cholesterol. Cow milk contains substances like carotenes, vitamin A, vitamins of B complex group and vitamin C. It also contains substances like flavones, sterols and phenols. Therefore, cow milk is considered as nutritious and has bio-protective effect in human health, kidney disorders, immunity, vision, ulcers, heart ailments, obesity, natural anti-oxidants, absorption of nutrients, diabetes, anaemia, a health tonic, increase microbial wealth and show anti-cancer properties.

Cow milk is an important component of the human diet worldwide, providing energy and nutrients that support the proper bone mass formation and contribute to adequate growth in children. Additionally, milk is important for neuropsychological development (Haug et al., 2007; Pereira, 2014). It is a traditional practice in Ayurveda to prescribe cow's milk along with certain medicines to enhance the efficacy/toxicity ratio. Casein is present in nano-form in the milk. Some phytoactives, like curcumin, would bind to casein and enhance absorption and systemic delivery (Kimpel et al., 2015). Over a century ago, Metchnikoff, a pioneer of cellular immune defence, popularized yoghurt as a healthy and longevity food (Mackowiak, 2013). Despite, certain concerns about the potential adverse effects associated with regular bovine milk consumption have been raised repeatedly over the last few decades including an increasing risk of cardiovascular disease, cancer and diabetes (Patterson et al., 2013; Aune et al., 2013; Hu et al., 2014; Aune et al., 2015).

The milk consists of protein (mainly casein and whey), fats (a spectrum of saturated, monounsaturated, and polyunsaturated fatty acids), carbohydrates (mainly lactose and oligosaccharides), and water. Approximately one-third of the protein fraction consists of beta-caseins which are insoluble milk proteins present in various genetically determined forms including the A1 and A2 variants. The A2 variant is considered the oldest variant, from which the others originated via mutation. The most common variants are A1 and A2 while rest of the variants including the B variant are less common (Farrel et al., 2004). In spite of the importance of milk, Woodford (2009) wrote a book titled 'Devil in the Milk' which raised a controversy for health benefits of A1/A2 types of milk. Beta-casomorphin-7 (BCM-7), a peptide from the A1 type, has an adverse impact on health. The seven-member peptide BCM-7 arises as a digestive by-product of the beta-casein in A1 milk from Bos Taurus cows, particularly H-F cows, due to the substitution of a proline residue by a histidine residue in the protein polypeptide chain. BCM-7 leaks into the bloodstream of people with leaky gut syndrome causing severe, fatal pathologies like atherosclerosis and schizophrenia. In nursing infants, it causes type 1 diabetes and autism. BCM-7 binds strongly to the opioid receptors and prevents them from their normal function of responding to endorphin activation. Endorphins cannot then fulfil their very important natural functions, and autism in infants or schizophrenia in adults follows. BCM-7 through activation of opioid receptors also triggers immune dysfunction leading to type 1 diabetes mellitus. Beta-casein in milk can occur as either A2 or A1 beta-casein.

Epidemiological evidence claim that consumption of beta-casein A1 milk is associated as a risk factor for type-1 diabetes, coronary heart disease, arteriosclerosis, sudden infant death syndrome, autism, schizophrenia etc. (Laugesen and Elliott, 2003; Tailford et al., 2003). In another study, American and European investigations have shown a reduction in autistic and schizophrenic symptoms with a decrease in A1 milk intake (Cade et al., 2000). The only difference in structures of the two beta-caseins is in the position of amino acid 67, in which histidine in A1 is replaced with proline in A2. Cow milk β-casein contains 209 amino acids (Fig. 1).

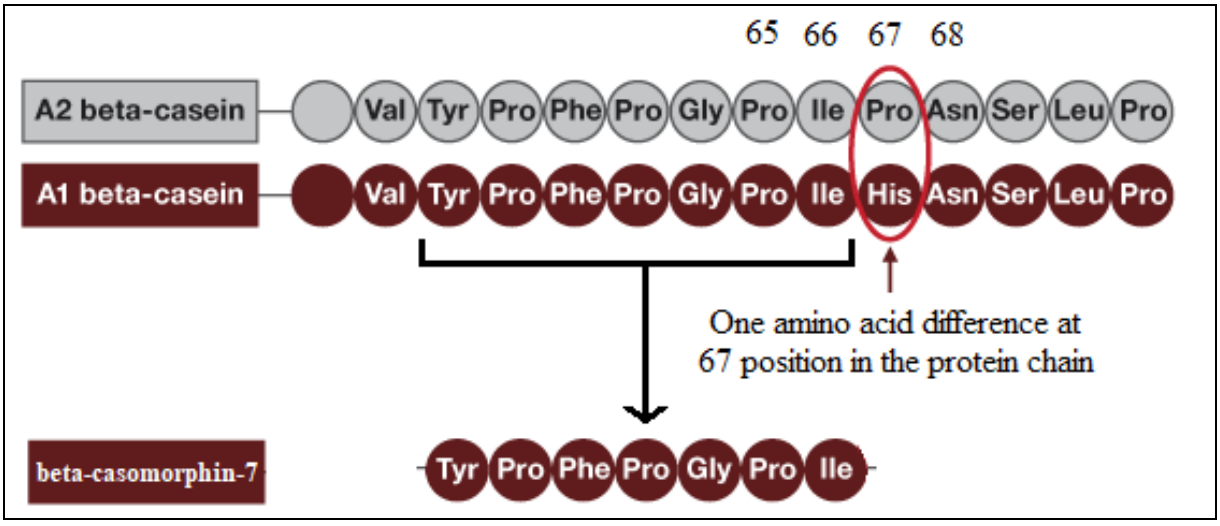

Fig. 1. Structures of A1 and A2 variants of beta-casein and beta-casomorphin-7

Remarkably, allergic reactions to cow milk casein can even vary between milk from different breeds of cow. Research over the last 20 years has shown that the A1 beta-casein protein in cow milk is more difficult to digest than A2, and, therefore, it has been speculated that A1 beta-casein is the main culprit for milk allergies or intolerances (Suchy et al., 2010; Woodford, 2009). However, there was no strong scientific evidence to support this idea until a pilot study (41 people; double-blind randomized) over 8 weeks conducted by Pal et al. (2015) discovered that the subjects consuming a diet containing A2 beta-casein milk showed less bloating and abdominal pain and had firmer stools compared to the subjects who consumed A1 beta-casein milk. A1 beta-casein is present in the milk obtained from the majority of European-origin cows but not in the milk from purebred Asian or African cows.

Digestion of A1 beta-casein releases a compound known as beta-casomorphin-7 (Fig. 1), which accordingly activates μ-opioid receptors in the human gastrointestinal tract and the human body. Activating μ-opioid receptors causes symptoms of allergy or intolerance in humans, especially children (Pal et al., 2015). Therefore, this mechanism may be the major factor in the allergies related to cheese; therefore, if the cheese is made from A2 beta-casein milk, casein allergies might be avoided. If this is the case, it will not be difficult for the dairy industry to breed cows that only produce milk containing A2 beta-casein instead of A1 beta-casein. However, more scientific evidence is required before general nutritional advice can be given. The new findings of the differences between A2 and A1 caseins have also caused the widespread assumption that the main reason of milk allergy or intolerance is the lactase deficiency questioned. Suchy et al. (2010) stated that "many who self-report lactose intolerance show no evidence of lactose malabsorption" but suffer from a different response to a specific compound in milk proteins.

In any extent, as the lactose in milk is converted to lactic acid during cheese making and/or ripening, cheese contains no or only nominal amounts of lactose. Therefore, any allergic reaction due to cheese consumption (especially mature cheese) cannot be related to lactose deficiency but more likely to the presence of A1 beta-casein. There have also been reports of allergy to the whey proteins (Meulenbroek et al., 2014; Suchy et al., 2010) in milk. However, whey proteins are unlikely to be the cause of allergic reactions due to cheese consumption as most cheeses contain very low amounts of whey proteins.

The milk having A2 beta-casein protein, which is easy to digest minerals such as calcium, potassium, phosphorus which are necessary for strong bones and teeth, better functioning of muscles, regulation of blood pressure, tissue and cell growth and enhancing good cholesterol (HDL) and maintain overall nourishment and well-being of the body. The study has also shown that β-casein variant A2 is desirable in milk because it increases the digestibility of milk (Sebastiani et al., 2020). This milk has essential Vitamins like Vitamin A, D and B12 which are necessary for bones and teeth, building immunity and converting food into energy. A2 milk provides Omega 3 fatty acids to increase immunity and metabolism. Consumption of A2 variant increases protective activity through the production of glutathione (GSH), and GSH level found in blood (Deth et al., 2016). It has been found that the milk composition of the cow does tend to vary among countries due to use of different breeds, feeding practices and breeding policies (Samkova et al., 2012). The superiority claimed by livestock farmers for Indian cow milk might have an association with the management practices that were followed during ancient times. *Rig Veda Samhita*, the oldest extant Indic text (2nd millennium BC) does mention (*Rig Veda Mantra* 10-169-1 and RV10-1692) about such feeding practices of the cows (Burjor, 2007). Rekha Sharma et al (2018) provide the comparative milk metabolite profiling for exploring superiority of indigenous Indian cow milk over exotic and crossbred counterparts (Sharma et al., 2018). Mishra et al. (2009) studied the status of beta-casein gene in native Indian cows and reported that all native cow breeds (Milch as well as non-milch cows) except Maland Gidda and Kherigarh breeds are pure A2 type (Mishra et al., 2009). Our Indian cow i.e. Badri cow is believed to be a superior breed as it gives high-quality A2 milk. On the other hand, European cow produce A1 rich milk. As per a research conducted by Uttarakhand State Council for Science & Technology (UCOST) and Indian Institute of Technology (IIT) Roorkee, the milk of Badri cow contains almost 90% A2 beta-casein which is the highest in any indigenous varieties (Hindustan Times, 2018).

BADRI COW (PAHADI COW)

Badri was formerly known as *Pahadi* cow, in 2011, the then Animal Husbandry Minister during his visit to Champawat district gave it a new name. Badri has become the first registered cattle breed of Uttarakhand which is certified by the National Bureau of Animal Genetic Resources (NBAGR). This breed is found in the hilly regions of Uttarakhand and balanced gait while walking. Badri cattle are small in size weighting 200-250 kg long legs and varied body colours viz. black, brown, red, white or grey (Fig. 2).

Fig. 2. Badri (Pahadi) cow

It has a straight forehead with a prominent poll and medium to large hump. The udder is small and tucked up with the body. These are well adapted to the hilly terrain and climatic conditions and comparatively more resistant to diseases (Pundir et al., 2014) and can play a significant role in the development of Uttarakhand as a real organic state (Banga et al., 2005; Chauhan, 2020). These are

mainly found in the hilly regions Nainital, Almora, Bageshwar, Pithoragarh, Champawat, Pauri Garhwal, Tehri Garhwal, Rudraprayag, Uttarkashi and Chamoli districts of Uttarakhand. The lactation milk yield ranges from 547 to 657 kg with an average milk fat of 4%. The body measurements in Badri cattle for heart girth, height at withers and body length were found to be 84.65, 103.97 and 100.76 cm, respectively (Banga et al., 2005; Savalia et al., 2019).

ADVANTAGES OF BADRI COW MILK

Badri cow milk contains almost 90% A2 beta-casein proteins, and hence easy to digest. There is 4.8% fat content in A2 milk instead of 3.6% in other milk. If one looking for sources of good fat, Badri cow ghee is appropriate to consume. The A2 milk is easy to digest because of the absence of BCM-7 because the presence of BCM-7 in A1 milk causes several health problems like heart disease and diabetes. Badri cow ghee is rich in antioxidants and also contains butyric acid. Butyric acid increases the production of killer T cells, which fights against allergens in our body. The presence of omega 3 fatty acids in A2 cow ghee is beneficial for the heart. Ghee of the grass-fed cow contains conjugated linoleic acid (CLA), a fatty acid, which is known to protect the body against several conditions such as diabetes and artery plaque. It also defends the body from carcinogens, which are substances that promote the formation of cancer in the body. Since CLA is a naturally occurring fatty acid, it carries fat-burning properties i.e. it makes the body disburse energy faster, thus enabling the fat to get burnt quickly. A2 Badri cow ghee contains vitamin K2 which ensures the deposition of calcium in the right places in the body. This helps in strengthening bones and teeth. It also helps in preventing the calcification of soft tissues, therefore, avoid the occurrence of several degenerative diseases. Badri cow ghee is rich in both vitamin A and E. Vitamin A aids glycogen production and protein synthesis, whereas vitamin E obstructs the effect of free radicals that are capable of hampering muscle growth. All in all, both these vitamins are essential for the growth of muscles in the body. The presence of butyrate and fatty acids in Badri cow ghee makes it a good cure for inflammation. This is because both of these acids tend to have soothing and anti-inflammatory effects.

CONCLUSION

The socio-political issues surrounding cow as a sacred animal has raised acrimonious debates. Historically, cows produced only A2 milk. It was due to human intervention and domestication that with time, cows developed A1 protein in their milk. There are only some studies to show the association between A2 casein milk and non-communicable disease. Although a large number of studies are yet to be conducted to set risk and disease. There is no such study in India related to the adverse effect of A2 casein on human health. Most of the Indian breed has A2 beta-casein in their milk and Badri cow is amongst them. This cow holds a significant place in the rural households of Uttarakhand hills but its overall contribution to the livelihood is very low and therefore, needs to be improved by conservation and promotion of Badri cow in rural areas. This can be done by spreading awareness about the importance of nutrition, better management practices among Badri cattle owners, identifying the specific nutrient requirements and assessing the nutritive value of various feed and fodder in the area. In this direction, there is a need of research to make people aware about the conservation and propagation of Indian cow.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

DECLARATION

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