International Journal of

Dairy Science

ISSN 1811-9743

Academic
Journals Inc.

www.academicjournals.com

International Journal of Dairy Science 7 (3): 70-72, 2012
ISSN 1811-9743 / DOI: 10.3923/ijds.2012.70.72

Designer Milk for Human Health: A Future Need

[1]Mahima, [2]Amit Kumar Verma, [3]Amit Kumar, [1]Vinod Kumar and [4]Anu Rahal
[1]Department of Animal Nutrition, [2]Department of Veterinary Epidemiology and Preventive Medicine, [3]Department of Veterinary Microbiology and Immunology, [4]Department of Veterinary Pharmacology and Toxicology, U.P. Pandit Deen Dayal Upadhayay Veterinary University, Mathura, 281001, Uttar Pradesh, India

Corresponding Author: Amit Kumar Verma, Department of Veterinary Epidemiology and Preventive Medicine, U.P. Pandit Deen Dayal Upadhayay Veterinary University, Mathura, 281001, Uttar Pradesh, India

ABSTRACT

Recently there is a rising interest in dairy biotechnology for altering the composition of milk by nutritional and genetic manipulations for the well being of human. These alterations are in milk fat, milk protein, lactose contents, humanization of bovine milk, adding therapeutic proteins etc. For acceptance of this designer milk we have to address certain ethical, legal and social aspects along with economic production of designer milk.

Key words: Designer milk, human health, milk fat

INTRODUCTION

Milk is a natural complete food, which provides fat, protein, essential vitamins and minerals and also a good source of calcium that is essential for the prevention of bone disorders such as osteoporosis (Gulati *et al.*, 2000). With the changing social and eating behaviour, the milk should be of special value so that it can compete with other dairy products and energy drink. For this milk have to be designed in such a way, which increase its properties according to the need of the changing scenario. Designing of the milk means production of the milk that has certain specific values viz., improve the immunity, utilization of lactose and alleviate diarrhoea. Low fat, more protein, less lactose, changed amino acid and fatty acid profiles and without b-lactoglobulin are important properties of 'designing' milk for human health point of view. Designer milks will give improved and value added products naturally with improved nutraceuticals to meet the requirements of the new millennium. Now a day's biotechnologists have identified genetic markers in cows for disease or desirable traits such as milk fat synthesis. So, in future we can expect the cows that will produce low fat milk naturally, which can be achieved through combinations of traditional genetics, marker-assisted selection and genetic modification of dairy cattle and by farm and feed management. From human health point of view some of the desirable improvements are- (1) Increased proportion of unsaturated fatty acids and low fat milk and its products, (2) Low lactose content and (3) complete absence of b-lactoglobulin from milk.

ALTERATION IN MILK FAT

The consumption of full cream milk is declining due to high proportion of saturated fats (i.e., 60%), which leads to increase in LDL (low density lipoprotein) in blood, a risk factor for heart disease (Noakes *et al.*, 1996). Milk fat designing means producing milk with low in fat particularly low saturated fat and increased linoleic acid in milk fat. This can be designed by change in feed for dairy animals and genetic interventions. Feeding rumen protected fat supplements enables the dairy animals to produce milk products containing structurally important dietary fats that are required for specific biological activities such as vision and neural development, antioxidants, anticancer substances and the dietary modification of genetically linked disorders viz., heart diseases. Feeding protected canola/soybean in ratio of 70/30 w/w significantly increased the proportion of C18:1 cis (oleic acid), C18:2 (linoleic acid) and C18:3 (linolenic). Similarly, protected soybean/tuna oil (ratio 70/30; w/w) significantly increased the proportion of C18:2 (linoleic acid), C18:3 (linolenic), C20:5 (EPA-eicosapentaenoic acid) and C22:6 (DHA; docosahexaenoic acid) while, feeding conjugated linoleic acid (CLA)/casein (1:1; w/w) supplements protected from ruminal hydrogenation increased the CLA isomers 9 cis 11 trans, 10 trans 12 cis. There was a reduction in the C16:0 (palmitic acid) by feeding protected supplements (Gulati *et al*., 2000). The alternative method to increase milk fat is selection of cattle based on DGAT1 genotype, which code for acyl-coenzyme A: diacylglycerol acyltransferase 1, is located on chromosome 14 in cattle (Grisart *et al*., 2002; Winter *et al*., 2002) and plays important role in synthesis of triacylglycerol.

ALTERATION IN MILK PROTEIN

Casein is main milk protein. Through genetic engineering, transgenic cows secreting elevated levels of b-(8-20%) and k-caseins (twofold) have been produced (Brophy *et al*., 2003). Brophy's group produced the transgenic animals, which have increased total milk protein by 13-20% and total milk casein by 17-35% in comparison to than that of non-transgenic cows. b-casein is the most abundant milk protein which is involved in binding calcium phosphate and controlling milk calcium levels. Higher k-casein content in milk is linked to smaller micelles, better heat stability and improved cheese-making properties. Adding L-taurine, L-leucine and L-phenylalanine in feed improved amino acid profile, which is another additional benefit.

MODIFICATION IN LACTOSE

The enzymatic hydrolysis of lactose is done by β-galctosidase into glucose and galactose and then their absorption into blood. In human beings, the level of β-galctosidase declines from early childhood to adolescent. When such adult ingest milk or their products, the lactose remain undigested leading to malabosrbtion, which further increase the water retention in gut and bacterial proliferation upset the gastrointestinal tract, which will lead to diarrhoea and dehydration. Since, milk is an important component of human diet especially for calcium, so lactose intolerance can limit this source. In later stage, this may cause bone disorders like osteoporosis.

HUMANIZED BOVINE MILK

It is well established that mother's milk is best for the newborn baby. In many of cases if there is non-availability of mother's milk than it can be replaced by cow's milk. But the composition of human milk and bovine milk differ in many aspects. One of them is lactoferrin (LF), the iron binding protein having antimicrobial property and role in regulating immune system. Its level in human milk is about 1 g L^{-1} (in human colostrum 7 g L^{-1}) while in bovine's milk it is only one-tenth than that of human milk.

REDUCING MILK ALLERGIES

In a study conducted on African and Americans (age group 12-40 years) the lactose content of milk was not the cause of cause of milk intolerance in one third of human beings (Johnson *et al*., 1993). In children, milk allergy to bovine's milk is due to b-lg, which is absent in human milk. Thus, elimination of this protein by knocking out gene responsible for b-lg from bovines is unlikely to have any detrimental effects on bovine and might overcome milk allergy problems associated with bovine milk.

MILK AND THERAPEUTICS

Scientists are trying to produce the proteins that can be helpful in human therapeutics. In this regards GTC Biotherapeutics (Framingham, MA) uses both cows and goats for the production of therapeutic proteins, including plasma proteins, monoclonal antibodies and vaccines. Recently, recombinant human antithrombin III has been produced in goat milk, which is an anti-coagulant protein in blood. Researchers are also working on production of vaccine against malaria from goat milk, which can be cheaper than current methods. With the use of biotechnology, it might be possible in future to produce specific antibodies (against *Salmonella*, *E. coli* and *Listeria* etc.) in mammary tissue that can prevent its own infection as well as helpful in preventing the disease in human beings and treating the diseases such as phenylketonuria (PKU), hereditary emphysema and cystic fibrosis. With the help of bioengineering, goat can be used in the production of spider silk in its milk that can be of immense help for preparing medical micro sutures and tennis racket strings.

CONCLUSION

Despite all these promising prospects, there is a tendency among human beings to resist change, especially those of transgenic. Thus, the future of biotechnologically modified foods is at crossroads even after three decades of promising results. Various ethical, legal and social issues should be solved before we would go for designer milk similar to organic herds. The future of the dairy industry is not just about producing more and more milk, but about producing more milk of the right kind. Thus, we can expect that in future dairy farmers may be the producers of designer milk.

REFERENCES

Brophy, B., G. Smolenski, T. Wheeler, D. Wells, P. L'Huillier and G. Laible, 2003. Cloned transgenic cattle produce milk with higher levels of β-casein and κ-casein. Nat. Biotechnol., 21: 157-162.

Grisart, B., W. Coppieters, F. Farnir, L. Karim and C. Ford *et al.*, 2002. Positional candidate cloning of a QTL in dairy cattle: Identification of a missense mutation in the bovine DGAT1 gene with major effect on milk yield and composition. Genome Res., 12: 222-231.

Gulati, S.K., S.M. Kitessa, J.R. Ashes, G. Simos, P. Wynn, E. Fleck and T.W. Scott, 2000. Designing milk fat for the new millennium by dietary strategies. Asian Aust. J. Anim. Sci., 13: 538-541.

Johnson, A.O., J.G. Semenya, M.S. Buchowski, C.O. Enwonwu and N.S. Scrimshaw, 1993. Correlation of lactose maldigestion, lactose intolerance and milk intolerance. Am. J. Clin. Nutr., 57: 399-401.

Noakes, M., P.J. Nestel and P.M. Clifton, 1996. Modifying the fatty acid profile of dairy products through feedlot technology lowers plasma cholesterol of humans consuming the products. Am. J. Clin. Nutr., 63: 42-46.

Winter, A., W. Kramer, F.A.O. Werner, S. Kollers and S. Kata *et al.*, 2002. Association of a lysine-232/alanine polymorphism in a bovine gene encoding acyl-CoA: diacylglycerol acyltransferase (DGAT1) with variation at a quantitative trait locus for milk fat content. Proc. Natl. Acad. Sci., 99: 9300-9305.