



Technews

**National Dairy Development Board
For Efficient Dairy Plant Operation**

September-October 2007

No.70

MILK AND HEALTH

This bulletin includes technical information based on latest developments on products, systems, techniques etc. reported in journals, companies' leaflets and books and based on studies and experience. The technical information in different issues is on different areas of plant operation. It is hoped that the information contained herein will be useful to readers.

The theme of information in this issue is **Milk and Health**. It may be understood that the information given here is by no means complete.

In this issue:

- **Introduction**
- **Overview of Benefits of Milk and Dairy Products**
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1. INTRODUCTION

The *Technews* (Issue No. 28, September-October 2000) provided a brief insight of nutritional value and health enhancing properties of milk and its constituents. Since then there have been numerous research findings and reviews further strengthening the scientific basis of milk truly being the nature's wonder food containing all of the essential nutrients for growth and its individual components providing specific health benefits to consumers. This emerging knowledge is leading the dairy industry and

researchers to develop processes that (a) not only increase the shelf life of dairy products but also ensure that the beneficial physiological properties of milk components are preserved and (b) harness bioactive components of milk for use in health foods, including functional foods.

This issue of *Technews* provides a review of the available scientific information on the role of milk and dairy products in providing nutrients that promote and safeguard consumer's health.

2. OVERVIEW OF BENEFITS OF MILK AND DAIRY PRODUCTS ^(1, 2, 3)

Milk not only contains all of the essential nutrients for growth, but provides much more than simply vitamins and minerals. The health benefits that milk has already been

recognized to provide include highly creative strategies to promote health, such as stimulating beneficial microflora in the gut, enhancing absorption of

nutrients, protecting the consumer by binding and eliminating toxins and pathogens, and educating consumer's immune system to the presence of potential pathogens.

Dairy product consumption has also been associated with decreased risk of a number of diseases that include osteoporosis, hypertension, colon cancer, obesity, insulin resistance syndrome etc.

Milk Proteins: The high nutritional value of milk proteins is widely recognized. As a result milk protein concentrates – particularly whey protein concentrates (WPC) and whey protein isolates (WPI) – and enzymatic hydrolysates of milk proteins have found use in a wide range of food stuffs, infant formulas and dietary supplements as well as in clinical and sports diets.

More recently, scientific and industrial interest has focused

on biological properties of milk protein. It is now very well known that not only native molecules of milk protein (such as immunoglobulins, lactoferrin etc.) exert distinct physiological functions, numerous bioactive peptides that are encrypted within intact protein molecules also have specific physiological functions. The knowledge of bioactive milk-borne peptides has steadily increased and several physiological activities, such as anti-oxidative, anti-hypersensitive, antimicrobial, cytomodulatory, immunoregulatory, opioid or mineral carrying are attributed to these bioactive peptides.

Milkfat: Milkfat contains a number of components having functional properties. It has fatty acids and membrane lipids that are believed to exert antimicrobial properties. A variety of health benefits have been associated with sphingolipids and their digestion products, ceramides

and sphingosines. They are suggested to be important in prevention of cancer, reduction of serum LDL cholesterol, regulation of immune system and inhibition of food-borne pathogens. Conjugated Linoleic Acid (CLA), a naturally occurring fatty acid in milkfat, is reported to exhibit a number of health benefits that include anticarcinogenic, anti-atherogenic, antidiabetogenic and immune modulating properties. Butyric acid and

ether lipids have also been suggested to have anti-tumour and cancer prevention properties. Vitamins A and D, and carotene are also reported as anticarcinogens in the scientific literature.

Some important and specific health enhancing and nutrition related benefits of milk, milk products and milk ingredients are briefly described in the following sections.

3. MILK COMPONENTS AND BONE HEALTH^(4, 5, 6)

Studies of bone health in children who habitually avoid milk show that they have low calcium intake and poor skeletons. They tend to be short and overweight, and they fracture more bones at young age than milk drinkers. Some recent studies have also revealed that adults who drank milk daily as children break fewer bones later in life than

those who drank infrequently before puberty.

In humans, many different components of dairy products contribute both to the growth of strong teeth and healthy bones in youth and to the maintenance of high bone mass later in life (*Table next page*).

In fact milk is a complex food containing many different

Table: Components of milk with relevance to bone metabolism	
Protein	Essential for growth and matrix production; consumption elevates IGF-1 levels which act to increase bone mass and enlarge the circumference of bones.
Minerals (Ca, P, K, Mg)	Influence hormones of PTH / Vitamin D / Calcitonin cascade; affect the absorption and excretion of other minerals; act as co-factors for enzymes and hormone secretions.
Lactose	Contributes energy and is claimed to augment alimentary calcium absorption; symptoms of malabsorption may lead to milk avoidance.
Lipids	Contribute energy / cell wall density.
Vitamins	Vitamin D has multiple actions on calcium metabolism; Vitamin K is an important co-factor for osteocalcin; Vitamin C is essential for bone matrix synthesis.
Essential trace elements	May influence mineral stability e.g. Fluoride; Co-factors for enzymes / hormones e.g. Magnesium for PTH, Zinc for growth hormone, Iodine for thyroid function.
Cytokines and bioactive fragments	Some augment osteoblastic activity e.g. lactoferrin; others inhibit osteoclastic activity and bone resorption e.g. osteoprotegerin, basic milk protein, cystatin C.
IGF-1: Insulin like growth factor PTH: Parathyroid Hormone. Osteoblastic activity: Formation of bone Osteoclastic activity: Resorption of bone	

nutrients that affect bone metabolism. Nutrients from dairy products can enhance bone health either as raw materials to build bone mineral content or matrix or to enhance processes that increase boneformation or suppress bone resorption.

Past research has focused upon the calcium content of fluid milk as of critical importance to the growth and maintenance of a strong skeleton. More recently, other milk nutrients,

including bioactive peptides, which affect osteoblasts and osteoclasts directly, have been identified.

Many experimental and clinical published data also prove that milk protein has beneficial effect on bone. Studies have also shown that while low protein intake causes decline in bone strength, high protein intake, including milk proteins, leads to high bone health and reduction in risk of hip fractures.

4. DAIRY FOODS AND THEIR ROLE IN WEIGHT MANAGEMENT ^(7, 8)

Obesity has become a major health issue world-wide. Emerging science indicates that consumption of dairy products may be part of the solution for mitigating the problem of obesity.

Dietary calcium appears to play a pivotal role in the regulation of energy

metabolism and obesity risk. High calcium diets, especially including dairy products, attenuate body fat accumulation and weight gain during periods of over-consumption of an energy-dense diet and to increase fat breakdown and preserve metabolism during caloric restriction, thereby markedly

accelerating weight and fat loss.

The research data indicate an important role for dairy products in both the ability to maintain a healthy weight and the management of overweight and obesity.

A substantial body of data has emerged over the last five years to indicate that dietary calcium and dairy foods modulate adipocyte lipid metabolism and energy partitioning between adipose tissue and lean body mass, resulting in a significant “anti-obesity” effect.

Increasing dietary calcium may also result in increased fecal fatty acid excretion and, accordingly, it is possible that the resultant increase in fecal energy loss could contribute to the anti-obesity effects of dietary calcium.

Although dietary calcium appears to inhibit adiposity, data from clinical trials, rodent

studies and population studies all indicate a substantially greater effect of dairy versus supplemental sources of calcium in attenuating adiposity.

An anti-obesity effect of dietary calcium and dairy foods is now evident from animal studies, observational and population studies and clinical trials. However, the available data indicate that substantial improvements in adiposity are unlikely to result from increasing dairy intake beyond an optimal range (approximately three daily servings).

The available research data provide a framework for the development of strategies to utilize dairy products and dairy ingredients for the prevention of overweight and obesity and, in conjunction with controlling energy balance, for effective weight management.

5. MILK AND CANCER ^(9, 10, 11, 12, 13)

A number of milk components have demonstrated anticancer potential in various studies.

Milk components like β -carotene, vitamin A, calcium, vitamin-D, cholesterol, sphingolipids, ruminic acid, vaccenic acid, butyric and branched chain fatty acids and cysteine-rich whey proteins in milk have the potential to help prevent various forms of cancer.

- **β -carotene and vitamin A.** Milk and milk products are significant contributors of β -carotene and vitamin A to diet. These components effectively inhibit cell proliferation, induce differentiation and promote apoptosis. Several studies have demonstrated that these substances, in particular β -carotene, protect against cancer.
- **Calcium and Vitamin D.** Studies have shown that an

increased intake of calcium and vitamin-D decreases mammographic breast density, which is an identified breast cancer risk. It has been found that both calcium and dairy product intake is associated with a survival benefit for women with breast cancer.

- **Ruminic and Vaccenic Acids.** Ruminic acid (RA) is the predominant natural isomer of conjugated linoleic acid (CLA), and milk fat is the richest natural source. Vaccenic acid (VA), the major *trans*-monounsaturated fatty acid in milk fat can be converted to RA in humans by an enzyme. It is reported that at physiological concentrations RA, VA and milk fat all arrested cell growth in breast cancer cells. Studies have found a significant inverse association between dietary

intake of RA and the risk of breast cancer. Tumor inhibition is independent of the amount or type (saturated or polyunsaturated) of fat in the diet, and is particularly effective when fed only during the period of mammary gland development to adult stage morphology.

• **Branched-Chain Fatty**

Acids. Branched, long-chain fatty acids (BCFA) are synthesized by bacteria in cow's large stomach. Some specific types of these BCFA, particularly those with a chain length of 13 to 17 carbon atoms, are found in milk fat. Recently, anti-tumour activity was found with 16-Carbon BCFA of a particular type, and the activity decreased with an increase or decrease in chain-length from 16 carbon atoms.

• **Butyric Acid.** Butyric acid, uniquely present in milk fat,

is a potent anticancer agent. Synergy with other dietary anticancer agents like vitamin A and vitamin D reduce the concentration of butyric acid required in the plasma to have anticancer effect. Studies have demonstrated that dietary butyrate significantly inhibited chemically induced mammary tumour development in rats.

• **Sphingolipids.** Milk is a rich source of sphingolipids. Sphingomyelin (SM) represents about one third of total milk phospholipids. The digestion products of sphingolipids (ceramides and sphingoid bases) are highly bioactive compounds that have been found to regulate growth, differentiation and apoptosis (programmed cell death) which are natural regulatory processes otherwise lost in cancer.

• **Milk Proteins.** Evidence

from animal studies and *in vitro* studies with human breast cancer cells suggests that milk proteins, especially those associated with the whey fraction, have anti-carcinogenic properties.

Lactoferrin, a minor milk protein, is considered to be effective as an anticarcinogenic agent. Selenized dairy proteins provide possible means for offering greater anticancer potential in the diet.

6. DAIRY COMPONENTS AND ORAL HEALTH ⁽¹⁴⁾

Dental caries (tooth decay) is the localized destruction of tooth tissue initiated by specific dental plaque bacteria that ferment dietary sugar to organic acids. The decay is initiated via the demineralization of tooth enamel by the organic acids liberated.

A substantial volume of literature now exists demonstrating an anticariogenic effect of dairy products which contain highly bioavailable form of calcium phosphate stabilized by the major milk proteins, the

caseins. This anticariogenic effect has been attributed to the multiphosphoryl-containing sequences of casein and their ability to stabilize calcium phosphate. The proposed anticariogenic mechanism of dairy products is the localization of calcium phosphate at the tooth surface, which buffers free calcium and phosphate ion activities, thereby helping to maintain a state of super-saturation with respect to tooth enamel preventing enamel demineralization and promoting re-mineralization.

7. DAIRY INGREDIENTS AND ENHANCED IMMUNITY ^(13, 15)

Milk contains many ingredients that help to protect neonates from infections. Consumption of molecules such as antibodies raised against pathogens may prevent enteric infections. Certain other components in milk can actively enhance immunity by changing the cellular activities of the immune system.

Passive protection of neonates against enteric pathogens comes from maternal milk and enhances survival. Protection is primarily due to immunoglobulins binding to pathogens. Oligosaccharides and glycoconjugates from milk also exhibit anti-infective properties as these agents may prevent intestinal attachment of infectious agents by acting as receptor analogues.

Some facts and research findings related to immunological activity of

various milk ingredients are given below:

- **Whey and its components.**

Antibody responses and the proliferation of lymphocytes are increased when proteins are incorporated into diets. Diets enriched with α -lactalbumin increased the function of blood and spleen lymphocytes and conferred resistance to challenge with bacteria. Further chemical modification of α -lactalbumin reduced the replication of HIV and fatty acids bound to α -lactalbumin also confer bactericidal properties.

Bovine lactoferrin, a minor milk protein, exhibits a wide range of host defence functions including anti-microbial and anti-viral.

- **Casiens.** The range of

immunomodulatory effect of caseins (α , β and κ) has been reviewed recently. α and κ caseins suppressed phagocytosis by murine macrophages, but β casein enhanced the activities of neutrophils and macrophages.

Peptides derived from casein molecules have potential immune modulating properties. There is evidence that peptides from α_{s1} -casein reduce infections of *Klebsiella pneumoniae* and *Staphylococcus aureus*.

- **Other molecules.** The nucleotide content of milk was reviewed recently. Immune responses are reduced when nucleotide intake is restricted and are restored by supplementation. Nucleotide supplementation of infant milk formula enhanced natural killer cell activity and secretion of cytokines by macrophages.

CD14 is a molecule present in milk and colostrum that binds to bacterial liposaccharides and activates toll receptors, a family of proteins that detect pathogens.

Colostrum and early post-partum milk contain high levels of immunoglobulins and when given in concentrated forms protect against some bacterial infections. Colostrum from hyper-immunized cows protect against a variety of pathogens, including bacteria and viruses. In a study, the incidence of diarrhea in AIDS patients was significantly reduced following consumption of bovine colostrum.

Sphingomyelin (SM) exerts a beneficial effect in gastrointestinal tract, protecting against bacterial infections.

8. CULTURED DAIRY PRODUCTS AND FUNCTIONAL FOODS (16, 17)

- **Probiotic/culture containing dairy products and their health effects.** Fermented dairy products, especially those containing probiotics, have many proposed health benefits. Relief of lactose maldigestion symptoms and shortening of rotavirus diarrhea are health benefits provided by many probiotic strains. Other health benefits, like reduction of allergy and superficial bladder cancer, have been well investigated for selected strains. However, for many other proposed health benefits, scientific information remains fragmented or inconclusive and requires further thorough investigation.

- **Dairy products and sports nutrition.** Each sport and physical activity has

differing demands on attention, energy, strength and weight.

Dairy products are an integral part of the recognized nutritional diets that address the requirements of most sports people to produce more power and maintain or achieve chosen body mass and body fat levels. There is general agreement in literature that dairy products (milk, particularly low fat milk, yoghurt, cheese) are nutrient dense source of protein, calcium and riboflavin (an aid in converting food into energy) and they are included as an integral part of specific sports nutrition plans.

Dairy is a rich natural source of protein with high content of essential amino acids and therefore, forms an important part of athlete's nutrition. There is evidence to support

the use of whey and casein proteins to build lean body mass and strength. Peptides derived from enzymatic proteolysis of milk (during processing and/or digestion) have a range of potential therapeutic uses with possible relevance to athletes. Protein supplementation is common practice, and whey is a preferred source. However, some recent clinical studies in power and endurance athletes have demonstrated performance and recovery improvements and a reduction in upper respiratory tract infections using concentrated bovine colostrum protein powder as compared with whey protein concentrate.

Dairy products are added to a high carbohydrate diet or form part of a carbohydrate-rich meals (e.g., milk and cereal,

flavoured yoghurt and fruit, low-fat cheese and pizza, sweetened desserts). Fruit yoghurt is recognized as a good source of carbohydrate for athletes.

It is advised to eat at least three servings of dairy food each day for achieving a good calcium intake by athletes. Athletes who are growing, or athletes who are pregnant or breastfeeding, need extra calcium and require dairy intake of 4-5 servings per day. In addition to calcium, it is also maintained that nutrient-rich foods including dairy products should be ingested to ensure adequate uptake of magnesium, phosphorous and iron to serve as cofactors to many enzyme-systems, sustain muscle and nerve excitation, and, in case of iron, maintain the oxygen-carrying capacity of blood.

9. EPILOGUE

Milk and milk products have immense properties that are beneficial to human health lifelong. The rich package of

conventional nutrients as well as specialized bioactive components has leveraged milk as an important part of the overall human diet. The consumption of milk and milk products, including dairy based functional foods, is now more confidently and scientifically linked to enhanced consumer

health and reduced risk of diseases. Thus, dairy industry is advantageously positioned in harnessing these beneficial properties of the nature's wonder food and in developing newer products and processes, ensuring that the benefits of milk and its components are available to the consumers.

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NEWS SECTION

Indian Food laws

- **Notification GSR 575(E) of 5 September 2007 of the Ministry of Health and Family Welfare:** The notification is a latest corrigendum to an earlier notification GSR 356(E) of 7 June 2005 (Refer News

Section of the *Technews* Issues No. 60). The Corrigendum indicates that the provisions in the GSR 356 (E) on the definitions, food additive provisions and microbiological specifications for specified dairy products (cheese, processed cheese, processed cheese spread, ice cream/kulfi/chocolate ice cream/softy ice cream, dried ice cream mix/ dried frozen dessert/confection, frozen dessert/frozen confection, milk ice/milk lolly and yoghurt) shall come into force after 3 years and 3 months from the date of publication of GSR 356(E). Therefore, these provisions are now likely to be applicable from 7 September 2008.

- **Notification SO 1568 (E) of 17 September 2007 of the Ministry of Health and Family Welfare:** The Notification amends the

Allocation of Business Rules, 1961 to allocate administration of the Food Safety and Standards Act 2006 to the Ministry of Health & Family Welfare.

- **Notification SO 1758 (E) of 15 October 2007 of the Ministry of Health and Family Welfare:** The Notification provides for enforcement, with effect from 15 October 2007, of some provisions of the Food Safety and Standards Act, 2006. These include Sections 4-10, 87 and 88 related to the establishment of the Food Safety and Standards Authority of India, and Sections 91 and 101 that empower the Government of India to make Rules for carrying out provisions of the Act and make such provisions not inconsistent with the provisions of this Act for removing of any difficulty in giving effect to the provisions of this Act.

Codex Alimentarius Commission

- The 39th meeting of the Codex Committee on Food Hygiene was held during 29 October – 4 November in New Delhi. During the Session, the Committee considered, among others, 4 documents at Step 4, a few new work proposals and matters referred by the Codex Alimentarius Commission (CAC). The items which were of particular importance to India included:
 - a) Proposed Draft Code of Hygienic Practices for Powdered Formulae for Infants and Young Children.
 - b) Proposed Draft Guidelines for the Validation of Food Safety Control Measures.
 - c) Principles and Guidelines for the Conduct of Microbiological Risk Management: Annex II- Guidance on Microbiological Risk Management (MRM) Metrics.
 - d) Microbiological Criteria for *Listeria monocytogenes* in Ready-to-Eat Foods.
 - e) Issue related to the use of lactoperoxidase system in milk and milk products for international trade, which was referred to the CCFH by the 30th Session of the Codex Alimentarius Commission (CAC).
- The Committee advanced three documents pertaining to powdered formulae (without Annex II of the Draft Code), validation of food safety measures and MRM metrics for final adoption by the CAC at Step 5/8 with the recommendation to omit steps 6 and 7. The Committee, however, lacked a consensus on lifting of the restriction on

the use of Lactoperoxidase System (LPS) in milk and milk products for international trade. It was, therefore, agreed to communicate the Committee's position to the Commission and also request CAC to consider clarifying that the restriction on the use of the LPS for milk in

international trade in no way precluded the use of the system by countries at the national level.

India's concerns pertaining to validation and MRM documents were adequately addressed during the discussions in the Committee and consequent revision of the documents.

International Dairy Federation

The IDF has published the following Bulletins/Standards recently:

- IDF Bulletin No.418/2007: Good Dairy Farming Practices Related to Primary Production of Milk and Farm Management.
- IDF Bulletin No.419/2007: Collaborative studies organized to include sheep and goat milk in the scope of joint standard ISO 5764/IDF 108: 2002 milk - Determination of freezing point - Thermistor cryoscope method (Reference method).

(This new IDF publication is available free of cost from the IDF Internet homepage: <http://www.fil-idf.org/Website/Documents/419-2007.pdf>).

- IDF Bulletin No.420/2007: Coagulation of Milk: Processes and Characteristics.
- IDF Bulletin No.421/2007: Foot and mouth disease and the dairy industry: problems and prevention.
- IDF Bulletin No. 422/2007: Reduction of Greenhouse Gas Emissions at Farm and Manufacturing Levels.

- IDF Bulletin No.423/2007: The World Dairy Situation 2007.
 - IDF 119 - ISO 18070: Milk and Milk Products - Determination of Calcium, Sodium, Potassium - Magnesium Contents - Atomic Absorption Spectrometric Method.
 - IDF 198 - ISO 22662: Milk and milk products - Determination of lactose content by high-performance liquid chromatography (Reference method).
 - IDF 171 - ISO 14501: Milk and milk powder - Determination of aflatoxin M1 content - Clean-up by immunoaffinity chromatography and determination by high-performance liquid chromatography.
- For purchasing the IDF publications, the following may be contacted:
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MILK AND HEALTH

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