



Dairy Industry in the next decade

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Overview of Indian Dairy Industry

- India is the top milk producer in the world, handling ~ 23% of world's milk. The CAGR in milk production is 6.2%. In 2020–2021, milk production reached 210.0 million tons.
- The top milk-producing states are [Uttar Pradesh](#) (14.9%), [Rajasthan](#) (14.6%), [Madhya Pradesh](#) (8.6%), [Gujarat](#) (7.6%), and [Andhra Pradesh](#) (7%).
- The Department of AH & Dairying (2020) **\$ 2.1 billion Infrastructure Development Fund** was allocated. An interest subsidy scheme to help Private and Small businesses invest in Dairy and Livestock feed plants - predicted to generate **3.5 million jobs**.
- The **MoFPI** has issued operational scheme guidelines and started an Internet-based platform for the '**Production Linked Incentive Scheme for Food Processing Industry**', with outlay of **\$ 1.4 billion**.



Biotechnological approaches towards increased milk yield

- Administration to dairy cows of a Genetically Engineered hormone **Recombinant bovine somatotropin (rbST)** would increase feed efficiency and milk yield.
- Use of drugs to induce multiple ovulation in cows, subsequent collection and fertilization of eggs produced and transfer of such embryos to recipient cows. (**Multiple ovulation and embryo transfer – MOET**).
- These 2 **biotechnological approaches** are being adopted in USA.

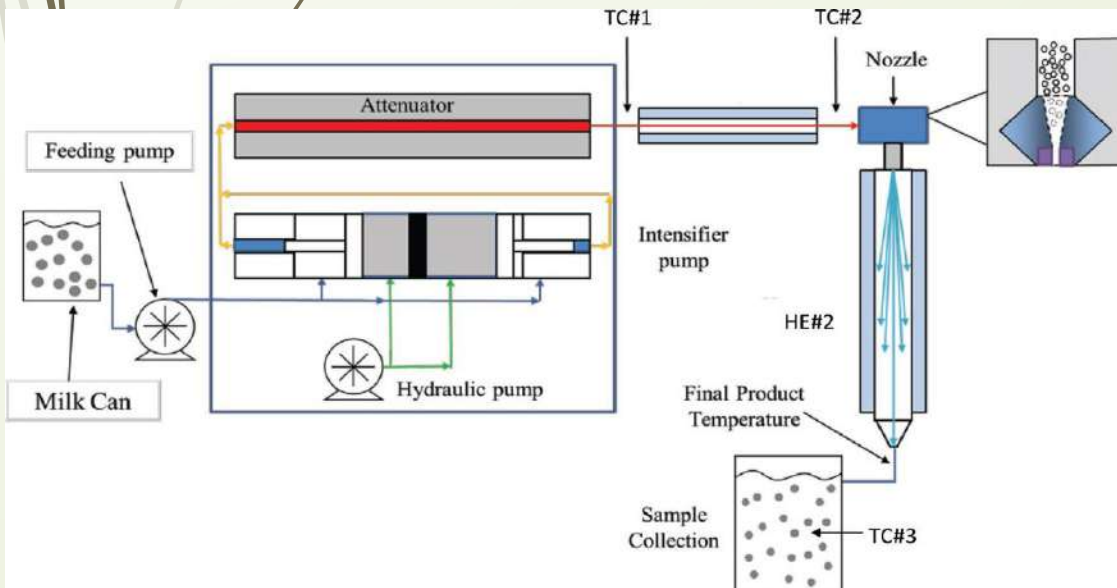


Dairy Ingredients – that adds value to dairy/food product

- Milk Protein Concentrates – 42, 70, 80 & 85; MPI 90
- Whey Protein Concentrates/Whey Protein Isolates – WPC 32, 72; WPI 92
- Micellar Casein powder (83% protein, 1% fat, 1% lactose, 5% moisture) Provides heat stability, viscosity, water binding in retort processed foods, including protein-fortified soups, sauces and RTE meals

Technological interventions in producing dairy foods

- High Pressure Processing/Microparticulation (**Simplese**)
- Pulsed Electric Field processing
- Membrane processes viz., **UF, RO, MF, NF**
- Induction heating for cheese processing
- Extrusion processing – Extruder Cooker (**Texturized dairy proteins**)



**High pressure jet
processing of milk**

Plasticizing Mozzarella cheese curd



Induction heating
method



Convection oven
heating method



Hot water method

Conventional vs. Novel Ingredients

- Fat substitutes ([Simplese](#), [Olestra](#), etc.)
- Bulking agents ([Polydextrose](#), [Pullulan](#), [Polyols](#), etc.)
- Intense sweeteners; Freezing point depressing sweeteners ([Stevia](#), [Aspartame](#), [Sucralose](#), etc.)
- Anti-caking agents ([Na-Al-silicate](#))
- Bleaching agents ([Benzoyl peroxide](#), [Titanium dioxide](#), [chlorophyll](#))
- Enzymes as food additives ([β-D-galactosidase](#), [Transglutaminase](#))



Wellness Dairy Foods

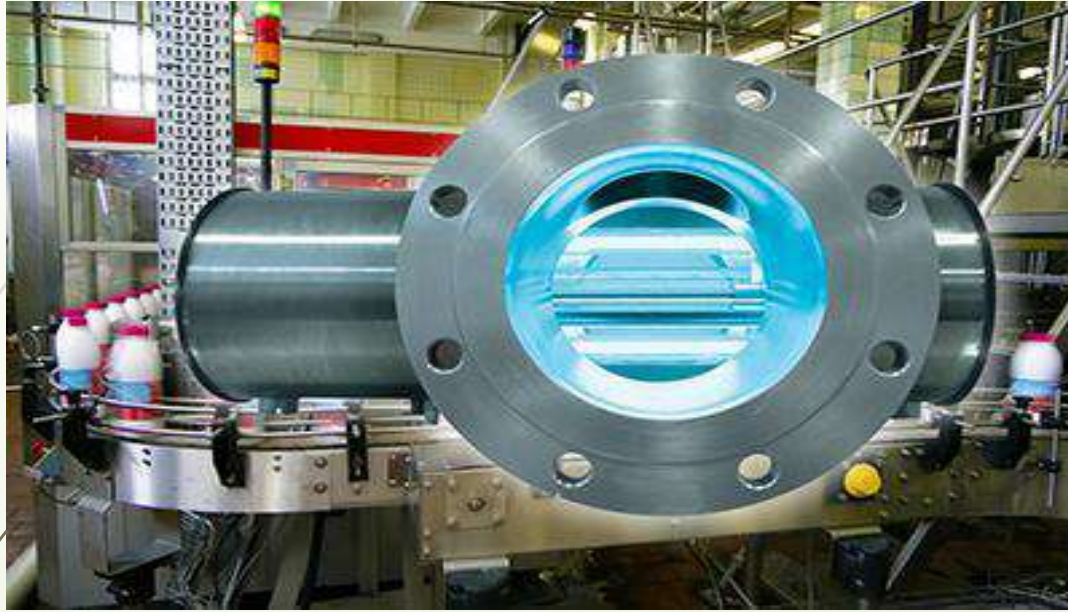
- CLA enriched milks
- Probiotic fermented foods
- Low-fat, low-cholesterol foods
- Low-salt dairy delicacies (Opposite – Proc. Cheese)
- Fiber enriched dairy foods

UV processing of milk

- ❑ Photopurification uses UV light to inactivate pathogens can possibly **outstrip pasteurization** of dairy products in future ([SurePure](#)).
- ❑ Uses radiation at germicidal wavelength of **254 nm** which inactivates pathogens, including virus.
- ❑ Provides big **energy saving** (heat is not required). Used in S. Africa and approved for use in India. [UV treatment of fruit juice](#) is approved by [FDA](#) in [US](#).
- ❑ In **Cheddar cheese** making, UV treatment did **not inactivate enzymes** for flavour and texture development; food safety standards were achieved.

Alternative Pasteurization method

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Ultraviolet Processing of Milk



Lactose-free milk



Lactose-free dairy products

- ❑ Globally, lactose-free dairy and ice cream products achieved 10% value gains in 2015.
- ❑ The US is the largest market for 'lactose-free food', accounting for 29% of global sales in 2015.
- ❑ Nearly **three quarters of Indian population** are suffering from some degree of **lactose intolerance** (Study in Lucknow).
- ❑ GCMMF was the first dairy company to introduce '**lactose-free milk**' in India under its AMUL brand.

CLA enriched milks

- Conjugated Linoleic Acid (CLAs) are reported to inhibit carcinogens, proliferation of leukemia, colon, prostate, ovary and breast cancers.
- Dairy products are rich in CLA – especially **fermented products**, a product synthesized in the rumen during bio-hydrogenation of linoleic acid.
- **Diets rich in linoleic acid** lead to increase in the CLA levels in milk fat **2-fold**. Incorporation of CLA along with soy oil in the diet of cows increased the CLA levels and simultaneously decreased SFA in milk fat. Milk from grass-fed cows has **5X greater** CLA vs. milk from grain-fed animal.

Melatonin enriched milk

- Sleep disorders like insomnia can be overcome by consumption of **Melatonin-enriched milk**. Melatonin acts as a terminal antioxidant which can mitigate various life-style diseases. Release of melatonin is **3-4 X higher** in milk, **let down before sunrise** vs. milked during day time. The secretion of melatonin in different individuals varies according to their age, gender, and seasons.
- The concentration of melatonin is **higher in winters** vs. summers. The concentration of melatonin also varies with the type of milk in line with CLA in different milks.



Membrane processes in Dairy Industry

- The integration of membrane processing (UF, NF, MF, RO) has been implemented throughout the milk and dairy processing chains
- Milk reception, Cheese making, Whey protein concentration, Fractionation of protein hydrolysates, Waste stream purification and effluents recycling and treatment.

Microfiltration – Membrane process

- The first industrial plant of **Microfiltration** was installed in **Sweden** which **increased the shelf life of pasteurized milk**, owing to the high retention of *Bacillus cereus*; shelf life increased to **16–21 days** (vs. 6–8 days for conventional) with attendant improved □flavour.
- Several hundreds of these systems (10,000-20,000 L/h) are currently running in **Europe** and **North America** for producing drinking milk.

Microfiltration – Membrane process

- MF is used in an integrated protein extraction process for the manufacture of **Micellar casein** products and **whey protein isolates**.
- Concentration by ultrafiltration (UF membrane pore size ~10,000 Da) of the milk microfiltrate directly produces **WPC** with a protein/TS ratio of 77%; can be increased to > 90% by diafiltration to produce **WPI**.

Nanofiltration – Membrane process

- Industrially, **Demineralization of whey** in the range 50-95% can be achieved by electrodialysis (ED) or ion exchange (IE).
- Nanofiltration makes it possible to achieve the concentration of dry matter (20–22% at VCR 4–5) and **demineralization** (25–50% and even 90% with diafiltration step) in a single operation. The process is **competitive** to RO and Electrodialysis.

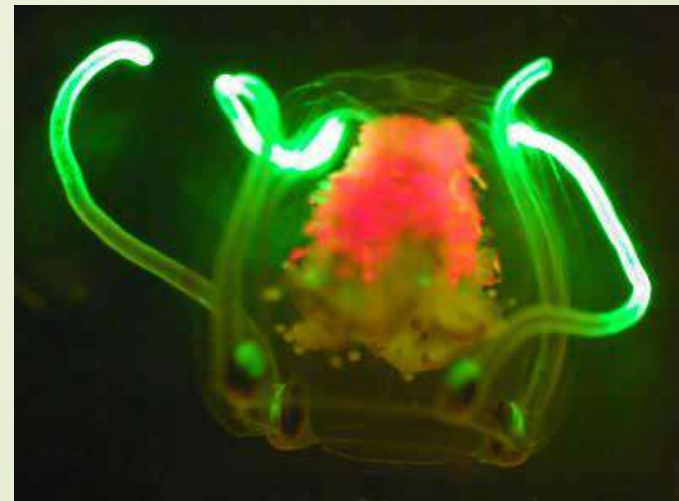
Commercial health-promoting dairy probiotic products

Sr. No.	Probiotic products	Probiotic strains
1	Amul Prolife probiotic ice cream	<i>L. acidophilus</i> , <i>L. bulgaricus</i> , <i>L. lactis</i> , <i>L. cremoris</i>
2	Yakult, Japan	<i>Lactobacillus casei</i>
3	Symbalance yoghurt, Switzerland	<i>L. reuterii</i> , <i>L. acidophilus</i> , <i>L. casei</i>
4	LGG Milk, Japan	<i>L. rhamnosus</i> GG
5	Bacilac, Belgium	<i>L. acidophilus</i> plus <i>L. rhamnosus</i>
6	Culturelle capsules, USA	<i>L. rhamnosus</i> GG
7	Crunch and Yoghurt, General Mills, USA	<i>L. acidophilus</i> , <i>L. bulgaricus</i> , <i>S. thermophilus</i>



Glow in the dark Ice cream

- British ice cream wizard **Charlie Francis** created “**Glow-in-the-dark ice cream**” using synthesized jelly fish proteins - that allow marine organisms to produce light inside their bodies through ‘**bioluminescence**’.



Fluorescent Ice cream

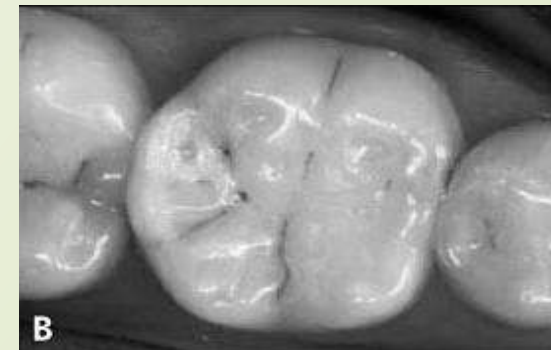


Courtesy of Charlie Francis

This glow-in-the-dark ice cream costs more than \$200 a scoop.

Frozen dessert with improved dental health

- The **optimum Ca:P ratio** needed to prevent dental mineral erosion, was said to be approximately that for **tri-calcium phosphate**, achieved by adding at 2 - 2.5% to the acidic agents (i.e. providing 600 $\mu\text{g/ml}$ Ca and 300 $\mu\text{g/ml}$ P).
- **Ice lollies/Sherbets/Ices** utilizes acidic fruit juices and tartaric acid is used to impart desired tartness. These are deleterious to the teeth health.



Utilization of Dairy Byproducts

- Utilization of **Whey**; source – Cheese, Paneer, etc.
- Utilization of **Sweet buttermilk**
- Utilization of **UF permeate**
- Utilization of **Ghee residue**

Utilizing Ghee Residue

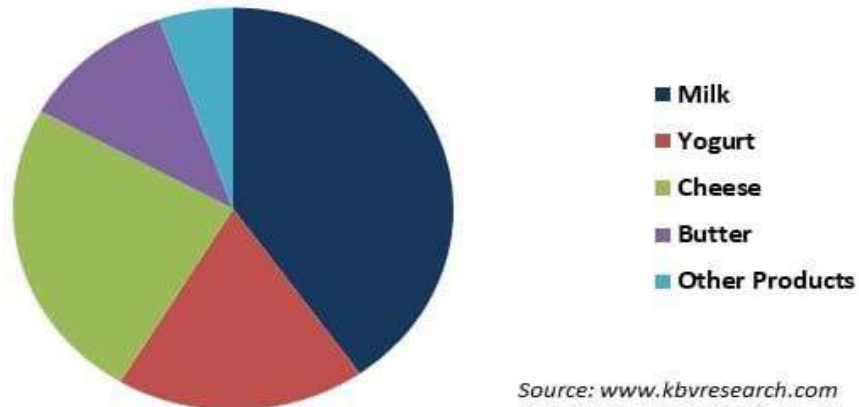


Ghee residue Rava Buttermilk Cake (Eggless)

Dairy commodity trends.....

- In recent years, there is increased consumption of **UHT milk**, use of new **packaging technologies**, and replacement of full cream milk with 'Specialist milk types'. The **long life shelf** capacity of UHT milk facilitates greater distances between sites of milk production and places of milk consumption.
- The expansion of the food service industry stems on the emergence of **global fast food chains** over the past 2 decades. **Dairy products are key ingredients to pizzas**. Pizza Hut (global sales US \$5 billion) and Dominos Pizza (global sales US \$3.2 billion) play a major role in encouraging standardization of product (**Pizza cheeses**) and through their buying power, place downwards leverage on dairy producers' pricing.

Dairy Products Market Share, By Product Type, 2020



Surge in Probiotic dairy foods

- Among food industries, the **dairy industry** is the largest sector where probiotics are employed in a number of dairy products viz., sour/fermented milk, yogurt, cheese, butter/cream, ice cream, infant formula, etc.
- These **probiotics** are either used as starter culture alone or in combination with conventional starters, or incorporated into dairy products following fermentation – depending on the probiotic strains used they confer several **health-promoting** virtues.

India INR 778 Million Probiotic Drinks Market, 2022-2027:
Leading Players – GCMF (AMUL), Mother Dairy Fruits,
Danone India
[ResearchAndMarkets.com](https://www.researchandmarkets.com)

Adoption of Solar Technologies

- To promote solar energy in industrial process heating, Gol has implemented **UNDP-GEF supported project** (UNDP-GEF, 2011) aimed to promote and commercialize **Concentrating Solar Technologies** for industrial process heat applications.
- In Indian dairy industry context, solar process heating potential of 1.88 PetaJoules (PJ) per annum was estimated (GIZ, 2011).
- Dairy sector has large potential for solar energy based process heating to meet its demand viz., pasteurization, other thermal energy requirements. Such solar energy based heating is estimated to meet **20–30% of total process heating demand of milk processing** in the organized dairy sector. This translates into potential for **Solar collector area** of **> 1.62 million m²** using such system.



**THE FUTURE OF
DAIRY INDUSTRY
IS
BRIGHT**