CONFERENCE PROCEEDINGS & COMPENDIUM

13th IDEA CONVENTION & INTERNATIONAL CONFERENCE

RECENT ADVANCES IN ENGINEERING APPLICATIONS FOR SUSTAINABLE DAIRYING

Editors : Dr. R.S. Sethi, Dr. Amandeep Sharma, Dr. Gajanann P. Deshmukh

Associate Editors: Dr. Harsh Panwar, Dr. S.K. Mishra, Dr. C.S. Mukhopadaya

COLLEGE OF DAIRY SCIENCE & TECHNOLOGY
GURU ANGAD DEV VETERINARY & ANIMAL SCIENCES UNIVERSITY
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PREFACE

The 13th Idea Convention and International Conference on Recent Advances in Engineering Applications for Sustainable Dairying is being organized by the Department of Dairy Engineering, College of Dairy Science and Technology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana held under the aegis of Indian Dairy Engineers Association. The focus of this event is to underline the issues related to dairy industry affecting the sustainability of this sector. The pertinent issues are related to climate change, maintaining cold chain during procurement and distribution of milk and milk products, application of IOT and artificial intelligence for better management of dairy practices, the use of new and renewable energy resources for safe environment and food safety and security for the better nutrition of human and livestock. This compendium is a compilation of oral presentations and poster presentations through which the researchers presented their scientific work.

Organizing Secretary

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Lead Paper

Engineering Approaches to Make Dairying Sustainable

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Introduction:

In one of the landmark developments in recent times, the United Nations in 2015 set out a blueprint for global progress in the form of 17 sustainable development goals (SDGs), which was then adopted by its member countries. This activity identified and encompassed different socio-economic and environmental aspects of living and emphasized the thrust on all mankind to develop a framework to take responsibility and improve ourselves towards achieving the said goals. The listed goals include No poverty (SDG 1), Zero hunger (SDG 2), Good health and well-being (SDG 3), Quality education (SDG 4), Gender equality (SDG 5), Clean water and sanitation (SDG 6), Affordable and clean energy (SDG 7), Decent work and economic growth (SDG 8), Industry, innovation and infrastructure (SDG 9), Reduced inequalities (SDG 10), Sustainable cities and communities (SDG 11), Responsible consumption and production (SDG 12), Climate action (SDG 13), Life below water (SDG 14), Life on land (SDG 15), Peace, justice, and strong institutions (SDG 16), Partnerships for the goals (SDG 17).

A quick perusal of the above goals in the context of Indian dairying (or dairying in general) would impress upon us that dairying has a direct or indirect impact on most, if not all, of the above SDGs. For example, dairying being a means for alternate livelihood for most farmers, with active participation from both genders, and providing nutrition to the vastly vegetarian population, has its influence towards realizing SDGs 1, 2, 3, 5, 8 and 10. Similarly, the nature of production, processing as well as the supply and value chain (both formal and informal routes) present in our dairying entitles us to be responsible towards the achievement of SDGs 6, 7, 8, 9, 11, 12, 13, 14 and 15. Moreover, the sector also has a role to play in achieving SDGs 3, 16 and 17 through the potential actionable in this area. Thus, the importance of dairying and efforts towards rendering the sector sustainable is well appreciated in the present era.

Among the various aspects discussed above, the most impact with respect to engineering services in dairying and its sustainability, would be related to its consumption of energy and water. Any action and responsible intervention to

conserve or reduce the two entities would have far reaching consequences on social, economic as well as environmental goals of both the industry itself as well as the society as a whole. We also need to appreciate that the intervention for conservation needs to start at point zero which is the point of production, i.e in all activities related to feed and fodder production, animal housing and well-being as well as the collection and supply chain till the point of processing. The dairy processing industry and post-processing supply chain is one of the most infrastructure sound sectors among the agri – processing sectors (along with the marine food industry); primarily owing to the highly perishable nature of milk. This provides us with the opportunity to deliver positive actionables with definite impact. Some of the potential engineering interventions in these directions are discussed below.

Typical Utility consumption – Measurement, Monitoring and Targeting

It is well understood that the degree of consumption of any utility, be it water or energy, is dependent on various factors, including scale and type of processing, installed capacity and its utilization, management practices etc. The energy demand in a typical dairy plant is reported to range between 0.8 to 1.9 MJ/ kg of raw milk processed (Malliaroudaki et al, 2022) with the demand being met via a mix of both thermal and electrical energy. Process flow lines dealing with short shelf-life dairy products usually report a mix of roughly 40:60 for fuel based and electrical energy, while long shelf life product have a more skewed energy source distribution (due to the extended cold chain requirement). Similarly, water which is undoubtedly a vital resource to all human activity, remains a key input to the dairy industry, both as processing ingredient, for steam generation and very importantly as a cleaning agent. A bird's eye view of the literature available on the topic indicate the water demand of anywhere between 1 – 10 times per kg of milk handled. A snap shot of the energy and water demand reported for a few products line in a typical Indian dairy plant is presented in Table 1.

Process	**Energy**	**Water**
Fluid Milk Processing (per 1000 L)	3000-5500 kWh ~20 kg steam	200 -320 L
Aseptic packaged milk (per 1000 L)	25 - 50 kWh	1.0 - 2.5 L
UHT Milk – PET botte (per 1000L)	120 - 135 kWh	1.0 - 2.5 L
Milk Powder (per 1000 kg)	280 - 330 kWh ~ 2000 kg steam	1200 - 2000 L
60- 80 % Thermal Energy, 20 - 40 % Electrical Energy		**Source: AMULfed report 20-21**

One of the gaps in managing these utilities is the lack of comprehensive and reliable data. The basic principle for any management strategy is "you can't manage what you can't measure". Realizing the importance of the same, the International Dairy Federation has issued guidelines to map the energy and water foot print of the dairy industry. However, the Indian dairying sector is unique in its structural framework related to the supply and value addition chain with both organized and unorganized channels actively contributing to the sector. Hence, there is a need to customize and formulate region specific methodologies as a policy framework for recording these data in our context. This would help generate and record consistent data on the subject, with access to all stakeholders for needful action. Another important activity for sustainability would be target setting and regular monitoring to achieve the goal of efficient utilization of these entities. The key to this approach would be to responsibly identify challenging yet achievable targets and strive to implement dynamic interventions to constantly downsize the target.

Regeneration / Recuperation / Reuse / Recycle

Among the engineering interventions to improve utilization efficiency are managerial decisions such as proper sizing of the plant and its equipment, appropriate model selection and full capacity utilization, regular maintenance activities and minor tweaks such as adjustable speed drives and regulated heat penetration in refrigeration plants. In addition to the above, it is to be noted that dairy industry has been and is continually devoted the 4 Rs listed above, which go a long way in enabling the circular economy and reducing the footprint of the industry. Some of the various interventions in these directions are listed below.

- Economizers for Flue gas / hot air heat recovery
- Heat line / steam condensate for heat regeneration
- Evaporators with Multiple effects and recompressors
- Condensate / Rinse water recovery with assistance through membrane processing
- Waste water recycling to ancillary operations

Innovative and novel approaches

The industry could explore the adoption and implementation of several novel approaches and innovative technologies that would assist in regulating and conserving the consumption of energy and water. Some of the options is this regard are discussed herewith.

- Co – generation and biogas-based generators – Combined generation of heat, power and refrigeration is an innovative approach which has already demonstrated its capabilities around the world. Similarly, installation of biogas based electrical generators at village level could be thought of as a means to reduce grid dependency at the collection centres.
- Adoption of zero discharge technologies such as high-pressure processing or high voltage technologies as an alternative to thermal processing of milk and dairy products. These technologies have proven records on lab scale and may need a scale up assistance before its adoption, but are options that could explored in the long run.
- New generation Heat transfer fluids and Phase Change Materials for more efficient heat transfer and passive energy applications during processing and transportation
- CIP systems are an integral part of the dairy processing industry and typically accounts for roughly of its 10 % energy and 25 % water consumption. Improved and optimal performance of this section through sensor-based automation and efficient valve designs as well novel cleaning agents such as enzyme-based agents and EOW for shorter cleaning cycles could be explored.
- Process automation – even though dairy plants are one of the highly reciprocal sectors that have adopted automation in big plants, there is still scope for more. Another avenue could be IOT based approaches for route mapping and traceability in the supply chain.

Other Initiatives / Practices

In addition to the interventions discussed above, the following miscellaneous steps would also contribute to the sustainability of the dairy industry.

- Greening drives in urban and semi – urban locales of the dairy plant
- Rain water harvesting and recharge of ground water
- Renewable energy initiatives through roof top solar panels / biofuels
- Switch over to LED lighting and sensor-based switch off
- Passive lighting and Ventilation approaches in dairy plant layouts
- Waste valorization and effective by – product utilization initiatives

Some of the above practices are already in vogue in the industry and sensitization of the management and personnel as well as incentives for adoption from the policy makers will boost its implementation further.

Closing Remarks

The Brundtland Commission (1987) defines sustainability as 'meeting the needs of the present

without compromising the ability of future generations to meet their own needs'. There is no doubt that the dairy sector is very aware of its role and responsibility towards achieving this goal. However, it requires a collective and collaborative effort from all stake holders right from the top to bottom, including the policy makers and government, industry, academicia to the individual farmer and consumer. It is indeed a challenge that is well appreciated, but should be looked upon as an opportunity for the betterment of the industry as we stride to the future.

Robotics, Artificial Intelligence and IoT Applications in Dairy Industry

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Introduction: Robotics

An industrial robot is a general-purpose, programmable machine possessing certain anthropomorphic (nonhuman things in terms of human) characteristics. The most obvious anthropomorphic characteristic of an industrial robot is its mechanical arm that is used to perform various industrial tasks. Other human - like characteristics are the robot's capability to respond to sensory inputs, communicate with other machines, and make decisions. These capabilities permit robots to perform a variety of useful tasks. The development of robotics technology followed the development of numerical control and the two technologies are quite similar. They both involve coordinated control of multiple axes (the axes are called joints in robotics), and they both use dedicated digital computers as controllers. Whereas NC machines are designed to perform specific processes (e.g., Metal machining, sheet metal-hole punching, and thermal cutting etc.), robots are designed for a wider variety of tasks. Typical production applications of industrial robots include spot welding, material transfer, machine loading, spray painting, and assembly. Reasons for the commercial and technological importance of industrial robots include the following:

- Robots can be substituted for humans in hazardous or uncomfortable work environments.
- A robot performs its work cycle with a consistency and repeatability that cannot be attained by humans.
- Robots can be reprogrammed. When the production run of the current task is completed, a robot can be reprogrammed and equipped with the necessary tooling to perform an altogether different task.
- Robots are controlled by computers and can therefore be connected to other computer systems to achieve computer integrated manufacturing.
- Applications of such systems range from assembly tasks in industrial automation to material handling in hazardous environments and servicing tasks in space.

The definition of a 'robot' – "Robot comes from the Czech word *robota*, meaning drudgery or slave-like labor". OR "A reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks" or also "It is a device with degrees of freedom that can be controlled." Class 1: Manual handling device; Class 2: Fixed sequence robot; Class 3: Variable sequence robot; Class 4: Playback robot; Class 5: Numerical control robot; Class 6: Intelligent robot. The design of pipeline milking system is shown in Figure 1. Most robots are designed to be a helping hand. They help people with tasks that would be difficult, unsafe, or boring for a human to do. Integrated Dairy Process Automation: It ensures no manual intervention and smooth sequencing & coordination of individually automated processes from Tanker Reception, Pasteurization, Homogenization, up to CIP in proper synchronization. It ensures the complete control and monitoring of total dairy process.

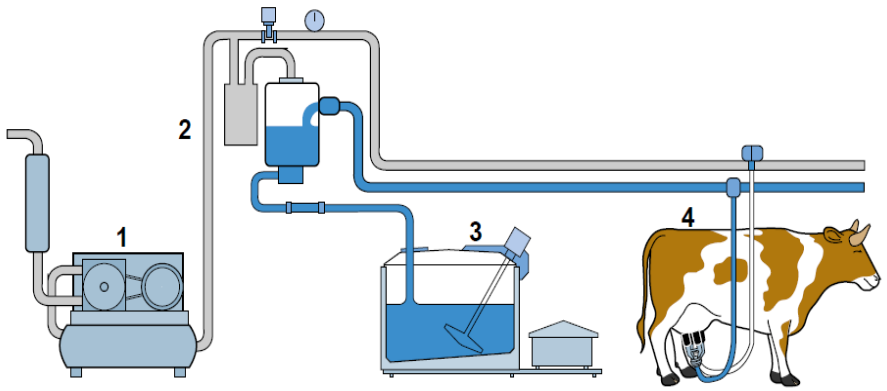

Figure 1:1. Vacuum pump 2. Vacuum pipeline 3. Milk cooling tank 4. Milk pipeline

Assured availability of individual process systems with uninterrupted milk production, availability of Sequence of Events (SOE), trend & data of dairy processes and also the ease of operation, maintenance and trouble shooting.

Robot Anatomy and Related Attributes: The manipulator of an industrial robot is constructed of a series of joints and links. Robot anatomy is concerned with the types and sizes of these joints and links and other aspects of the manipulator's physical construction.

Joints and Links

A joint of an industrial robot is similar to a joint in the human body. It provides relative motion between two parts of the body. Each joint, or axis as it is sometimes called, provides the robot with a so-called degree-of-freedom (d.o.f.) of motion. In

nearly all cases, only one degree-of-freedom is associated with a joint as shown in Figure 2. Robots are often classified according to the total number of degrees-of-freedom they possess. Connected to each joint are two links, an input link and an output link. Links are the rigid components of the robot manipulator. The purpose of the joint is to provide controlled relative movement between the input link and the output link. Most robots are mounted on a stationary base on the floor.

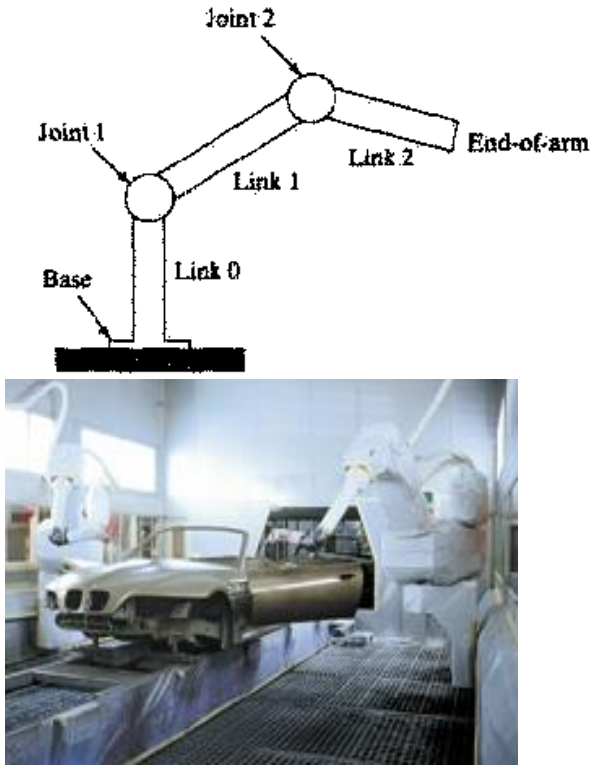

Figure 2: a) Diagram of robot construction showing how a robot is made up of a series of joint-link combinations and b) Robot application in Spray painting.

Nearly all industrial robots have mechanical joints that can be classified into one of five types: two types that provide translational motion and three types that provide rotary motion. These joint types are illustrated in Figure 3. The five joint types are:

(a) Linear joint (type L joint): The relative movement between the input link and the output link is a translational sliding motion, with the axes of the two links being parallel.

(b) Orthogonal Joint (type O joint). This is also a translational sliding motion, but the input and output links are perpendicular to each other during the move.

(c) Rotational Joint (type R joint). This type provides rotational relative motion, with the axis of rotation perpendicular to the axes of the input and output links.

(d) Twisting joint (type T joint): This joint also involves rotary motion, but the axis or rotation is parallel to the axes of the two links.

(e) Revolving joint (type V joint, V from the "v' in revolving). In this joint type, the axis of the input link is parallel to the axis of rotation of the joint. and the axis of the output link is perpendicular to the axis of rotation.

Each of these joint types has a range over which it can be moved. The range for a translational joint is usually less than a meter. The three types of rotary joints may have a range as small as a few degrees or as large as several complete turns

joint (type L joint), (b) orthogonal joint (type O joint), (c) rotational joint (type R-joint), (d) twisting joint (type T-joint), and (e) revolving joint (type V-joint), (f) Milk plant

Stepper Motors: Normal DC motors spin either forwards or backwards when current is applied. A stepper motor moves in very small steps instead and it makes a precise number of stepped revolutions to move the robotic arm in very small increments to the correct position. The computer controls the movement of the arm of an industrial robot, so that a variety of jobs can be carried out. The jobs carried out depend on the end effector attached to the arm.

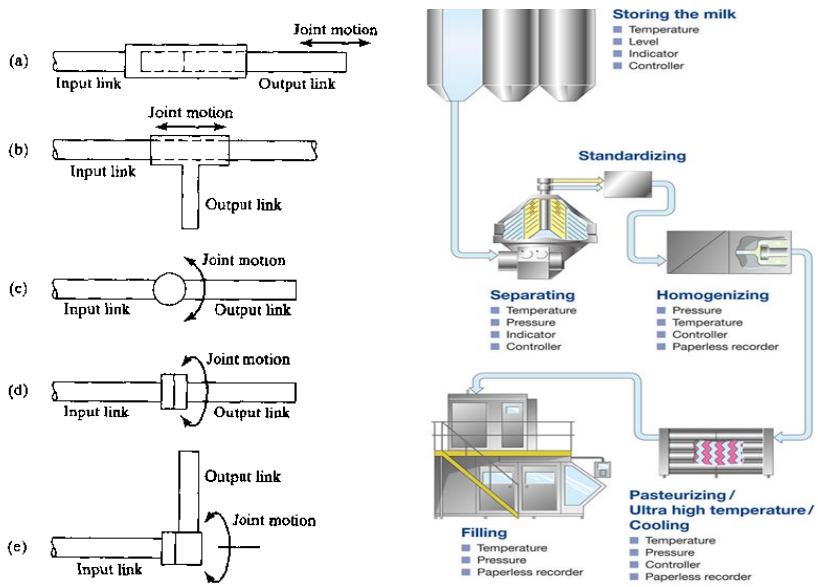

Figure 3: Five types of joints commonly used in industrial robot construction: (a) linear

Types of end effector OR Gripper: To pick up parts and put them somewhere else where required. Grippers usually have pressure sensors built in to them to hold the object with optimum pressure. These sensors tell the robot how hard it is gripping something so that the robot doesn't drop or break it

Figure 4: Types of end effector OR Gripper

In advanced dairy plants robotics and mechanization chiefly consists in either replacing, or assisting or doing away with both the animal and human labour in processing operations and controls by mechanical power wherever possible. Robotic arms are used extensively in car manufacture. Robotic arms generally have 7 sections with 6 joints. Each joint is controlled by an actuator (a stepper motor). Normal DC motors spin either forwards or backwards when current is applied. A stepper motor moves in very small steps instead. It makes a precise number of stepped revolutions to move the robotic arm in very small increments to the correct position.

Mechanization is partial when only a part of the processing operations is done by machine. When animal as well as human labour both are completely dispensed with by robots or power supplying machines, it is termed as complete. The robotics and mechanization (Automation) technique eliminates drudgery, reduces process time & labour, allows easy & precise control of process parameters to manufacture quality dairy products by avoiding manual interventions in the various unit operations involved in quick time. This technique could assure high quality of value-added dairy products with optimal processing. Mechanization by automation and instrumentation has become an important component of today's dairy industry (Nakra and Chaudhry, 2009). Hygienic design of sensors and transducers employed in robotics and instrumentation is essential requirement in equipment design for value added dairy products.

Robotics, Automation *and* ***Instrumentation*** has become an important component of today's advanced dairy industry and helps in producing high quality Value Added Dairy Products with optimal processing. The appropriate material of sensor in contact with product, proper way of mounting them and trouble-free working of sensors helps in minimizing contamination to get quality Value Added Dairy Products.

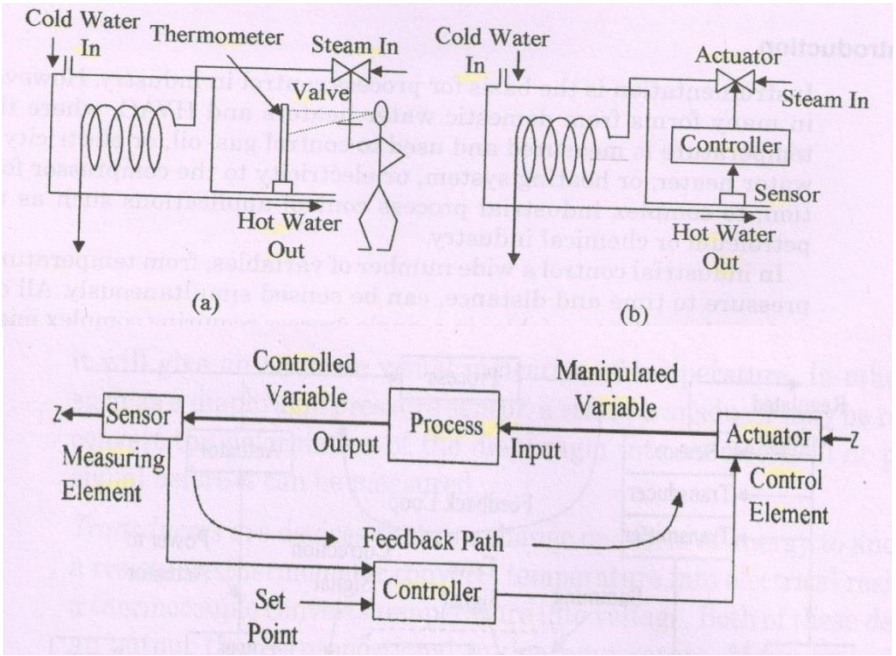

Figure 5: (a) Manual control of a simple heat exchanger process loop & (b) Automatic control of a heat exchanger process loop and Block diagram of a process control loop

Most processes will perform well and efficiently only when the values of certain process variables are held within given limits. Thus, the fundamental function of process control is to manipulate the energy (or material) input to output relationship so as to keep the process variables within desired limits. An automated controller can be defined as a mechanism that measures the values of a process variable and operates to limit the deviation of that variable for desired value (Chitranayak & Manjunatha M., 2014). A process variable that is held within limits termed as controlled variable. The automatic controller regulates the controlled variable by correction to another variable of the process which is termed as the manipulated (or controlling) variable. Principles of automatic controller: Here, controlled or dynamic variable is the temperature of the hot water. The desired value is the desired

hot water temperature. The manipulated or controlling variable is the rate of steam flow. Any change in steam value opening as dictated by the automatic controller comprises a correction to the manipulated variable. Thus, it is possible to hold or change the output hot water temperature by manipulating the balance of energy input to energy output.

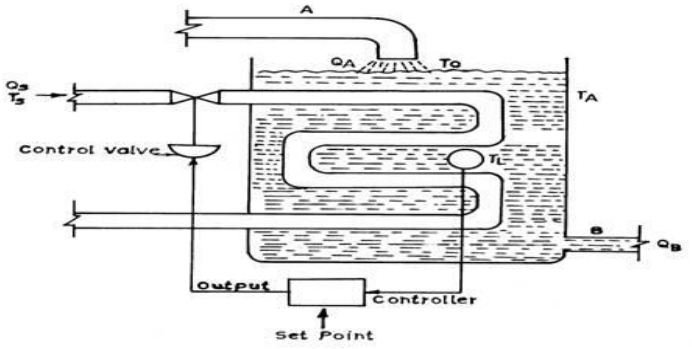

Figure 6: Automatic control of a heat exchanger process

The above example is for the CIP of a dairy plant, where the hot water at set fixed temperature is required after each batch of milk production. The set temperature of the water at output is controlled automatically as described above for conducting the CIP operations in a dairy plant.

Figure 7: Automatic robotic control of a Plant and robotic milking system in dairy farming

Robotic technologies can perform a variety of tasks with the help of advanced sensing, controlling, and actuation. Robotics is a multidisciplinary field that brings together computer science and engineering to design and develop machines that can assist or even substitute humans and replicate human actions. In the past decades, the field of robotics was growing rapidly as technological advances continue. With the introduction and further improvement of artificial intelligence, robots are able to better mimic human behavior and manage tasks in a human-like fashion.

In dairy farming, robots are mainly used for automatic milking, feeding and feed pushing, and manure handling. In robotic dairy farming, these laborious and repetitive tasks are being taken over or largely supported by automated technology (Chitranayak et al., 2018). The main advantage of using robots for dairy farming is the increased flexibility for farmers on how they use their time, also allowing devoting more time to farm management.

Robots come in many shapes and sizes. Robots consist of a number of components that work together: the controller, the manipulator, end effectors, a power supply, and a means for programming (Schilling, 1990). An actuator is a motor or valve that converts power into robot movement. This movement is initiated by a series of instructions, called a program, stored in the controller 's memory. The manipulator consists of segments that may be joined and that move about, allowing the robot to do work. The manipulator is the arm of the robot which must move materials, parts, tools, or special devices through various motions to provide useful work. The end effector is the robot hand, or the end-of-arm tooling on the robot (Hamraj Singh, 2018). It is a device attached to the wrist of the manipulator for the purpose of grasping, lifting, transporting, maneuvering, or performing operations on a work piece. The use of robotics in the food industry has increased over recent years, particularly in the field of processing and packaging systems. However, the industry has not taken to the technology with the same enthusiasm as the automotive and other industries. Now that the technology is becoming more affordable and the systems more intelligent, it may be feasible to automate many of the complex and repetitive tasks that are carried out in the food industry.

Artificial Intelligence (AI): Artificial intelligence leverages computers and machines to mimic the problem-solving and decision-making capabilities of the human mind. It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is the ability of a computer or a robot controlled by a computer to do tasks that are usually done by humans because they require human intelligence and discernment. AI is the ability of software to solve problems and perform tasks that otherwise requires human intelligence. A common, well-established application of AI is identifying 'normal' or expected shapes, colours, patterns and so on and also therefore detecting deviances from these norms. Already, AI in robotic milking systems decides if a cow should be milked or not at a given time and reports to the farmer about disruptions to normal feeding patterns, milk quality and more. Some dairy farmers are now also using virtual

fence systems, similar to technologies for pet dogs, where AI manages the movement of pastured cows to optimise pasture use.

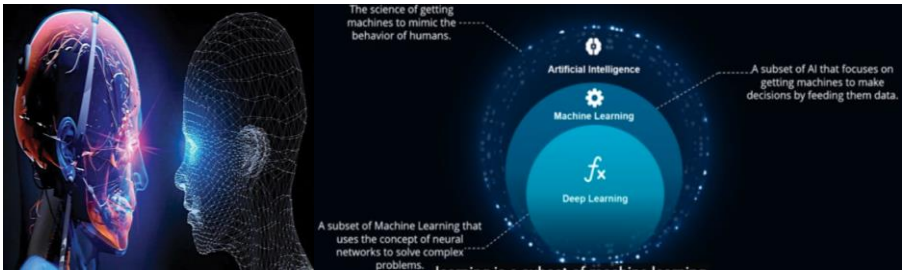

Figure 8: Artificial Intelligence (AI) control

The cows wear GPS-enabled collars which move them along with beeps or mild electrical pulse as needed to optimise pasture use. (Read about virtual fencing systems developed in the UK, Australia and WUR University in the Dairy Global story here). Here is another dairy farming example. Back in 2017, Professor Yago Yasushi at Osaka University in Japan developed an AI system to detect laminitis, digital dermatitis, and other issues through analysing a dairy cow's gait (however, the system does not appear to be commercialised). The farmer points a hand-held scanner towards a given cow, and the software identifies anything about the gait that falls outside of normal bounds, and which therefore may signify disease. The software first 'learned' what a normal gait looks like through exposure to large amounts of data (in this case, video of cows walking normally). It is reported to have almost a 100% accuracy rate in detecting abnormalities. Performance information on individual cows and at the herd level (milk yield, disease incidence, feed intake for example) is obviously best combined with other sources of data such as weather conditions to provide guidance for continuous improvement of management practices and data-driven decisions.

Internet of Things (IoT): Internet of Things (IoT) applications are widely envisioned as a major use case in the forthcoming fifth-generation (5G) mobile networks and would account for one-quarter of the global 41 million 5G connections in 2024. Meanwhile, security is a top concern for large-scale IoT deployment, which is subject to new, disparate kind of threats and attacks. IoT is the vast network of digitally connected devices and machines and the digital connection of the machines or things occurs over the Internet. It is the network of physical devices, vehicles, buildings and so on embedded with electronics, software, sensors and network connectivity that enable these objects to collect and transmit data via the internet as shown in Figure 9.

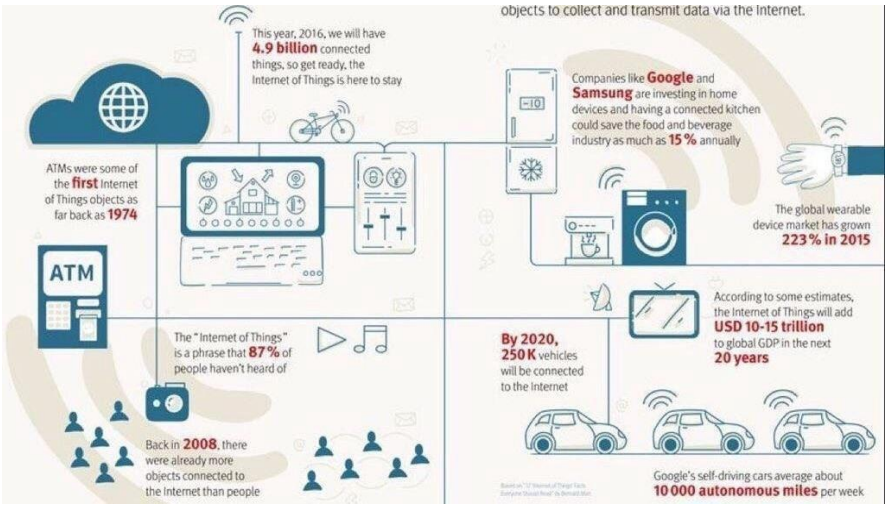

Figure 9: IoT Network of physical devices, vehicles, buildings and so on embedded with electronics, software, sensors.

IoT provides robust communication between the physical world and the digital systems, a concept of the fourth industrial revolution. Use of IoT in industry is sometimes also referred to as Industrial IoT (IIoT). In the IIoT framework, remote sensors gather information generated by machines (and increasingly, human beings too) to increase efficiency, promote better decision making, and build competitive advantages, regardless of industry or company size.

IoT platforms serve as the bridge between the devices' sensors and the data networks, wherein the connected IoT devices exchange information using Internet transfer protocols.

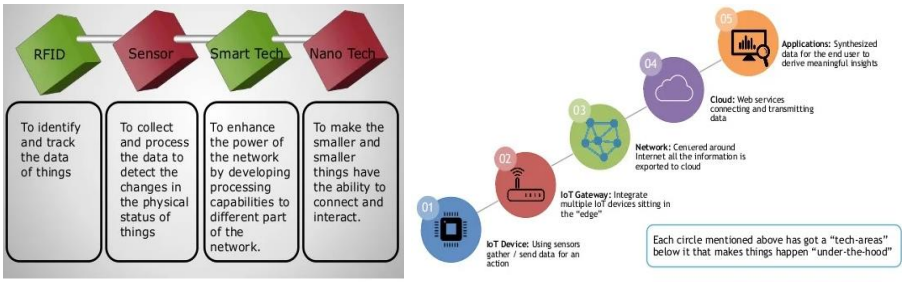

Figure 10: a) IoT working and b) IoT Device-Gatway-Network-Cloud-Application network

Internet of Things (IoT) applications are widely envisioned as a major use case in the forthcoming fifth-generation (5G) mobile networks and would account for one-quarter of the global 41 million 5G connections in 2024. Meanwhile, security is a

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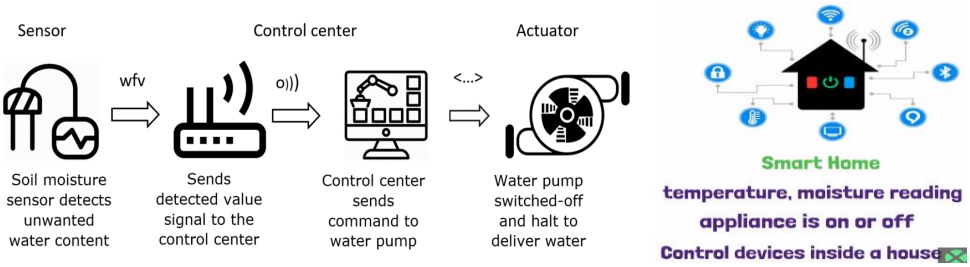

Figure 11: Flow-diagram of IoT: Soil moisture sensing-sending data-control center & command-ON/OFF water pump

Conclusion:

Automatic milking systems (AMS) or milking robots are one of the most successful and important application of robotics in the dairy industry. The commercial application of robots in dairy industry is also widely spread at the end of processing lines like packaging and palletizing. The robots of today are based on computer technology. The robotics industry is thriving. Higher production capacity can be achieved using robots. Higher quality products are manufactured using robots. *Robots don't talk back!* AI is planned to provide much broader services on a farm, a partner that helps farmers protect cow health, boost milk production and improve farm productivity. Milking robots, also known as automated milking systems (AMS), use sophisticated sensors and algorithms to monitor cows, milk them, and even clean them. AI (Artificial Intelligence) has had a significant impact on the future of milking robots, transforming the way cows are milked and managed on dairy farms. The milking robots' market has been witnessing steady growth in recent years, driven by the increasing demand for automation in the dairy industry. Internet of Things applications are the forthcoming fifth-generation (5G) mobile networks and would account for one-quarter of the global 41 million 5G connections in 2024. Meanwhile, security would be a top concern for large-scale IoT deployment, which is subject to new, disparate kind of threats and attacks.

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Managing Cold Chain in Dairy & Food Business

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Introduction:

Dairying plays a crucial role in contributing to the livelihoods of crores of rural households particularly women and small-scale and large-scale producers. India is the largest producer of milk in the world, contributing 23% of global milk production. India's diverse agro-climatic zones facilitate year-round milk production. Total milk production during 2021-22 is 221.06 million tonnes with annual growth rate of 5.29%. The per-capita availability of milk is 444 gram/day during 2021-22.

Importance of Dairy Industry in Indian Economy

- The industry encompasses a wide spectrum of stakeholders, ranging from small-scale farmers with one or two milch animals, to organized dairy farms with large herds.
- The dairy sector significantly contributes to India's economy. It generates income and supports livelihoods of crores of peoples.
- Dairying and animal husbandry sector contributes around 5 % of country's Gross Domestic Product (GDP) and it witnessed 6.4% (CAGR) in the past 5 years.
- Contribution of dairy sector to agriculture sector is 24 %, which is valued around Rs 10 Lakh crore and it is highest in the world.
- Contribution of dairy sector is more than combined contribution of wheat and rice crops.

Significance of Cold Chain Management

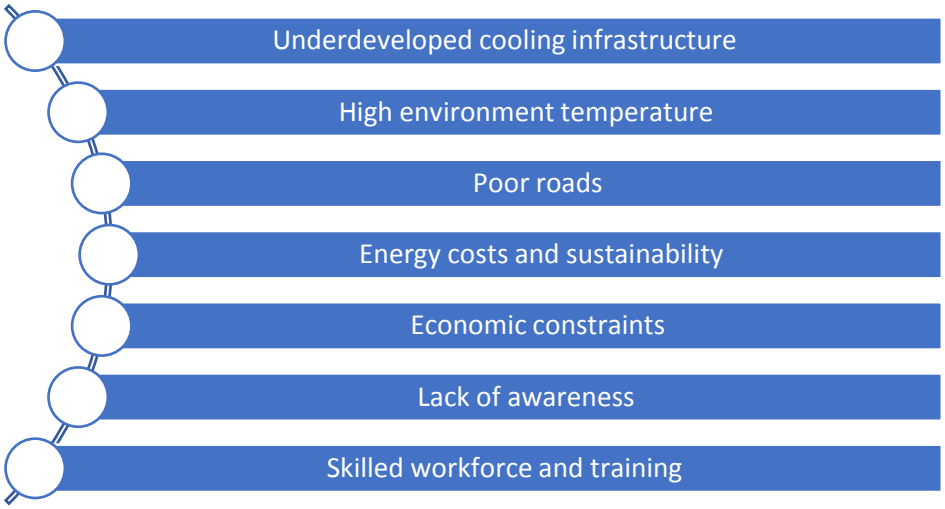
Cold chain management in the dairy industry is the comprehensive and proactive management of the temperature of dairy products throughout the supply chain, from farm to fork, to ensure safety, quality, and traceability. To

maintain good quality of milk, and to prevent from bacterial growth, it is necessary to chill it immediately after milking, from 35 degrees to 4 degrees Celsius, in less than 3 hours, and then to maintain it at 4 degrees.

Key Components of Cold Chain

- Bulk Milk Coolers (BMC) of varying capacities are used at village level for chilling milk and BMC also serves as buffer storage prior to onward transportation and further processing at milk plants.
- Cold Storage facilities at milk plants.
- Processing Facilities for maintaining processing and filling temperatures.
- Cold chain for transportation of milk and milk products through insulated or refrigerated vehicles (usually more than 100 km)

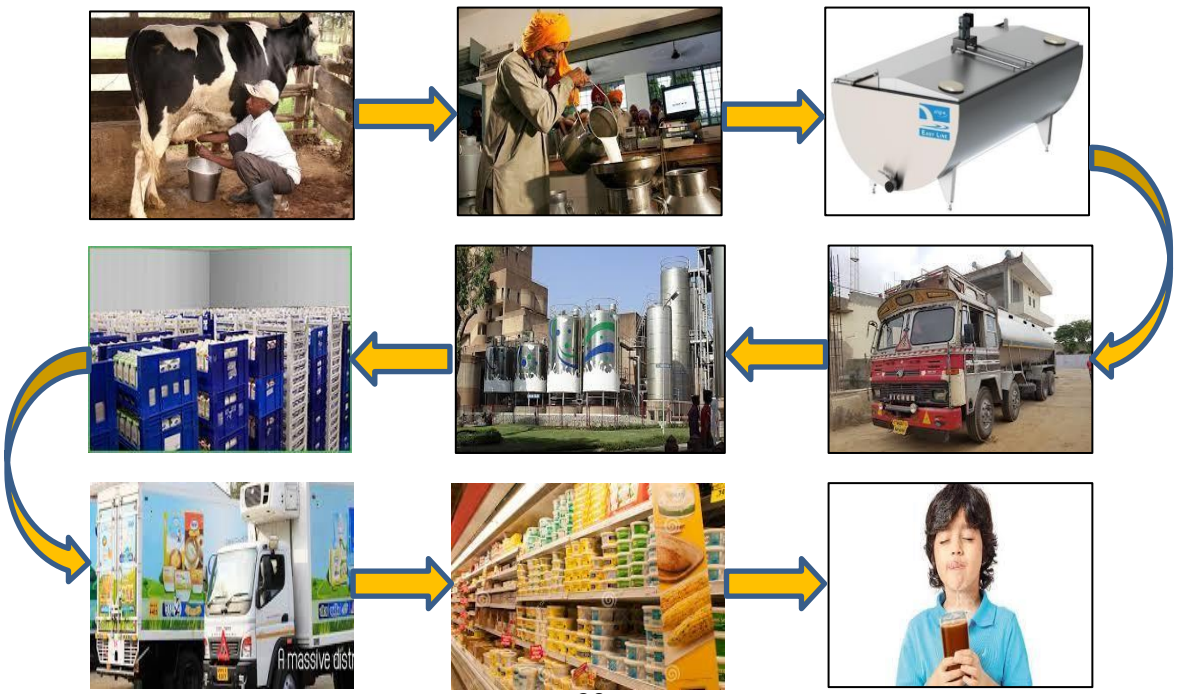
Challenges in Cold Chain Management



Regulatory framework governing cold chain in India

Food Safety and Standards Authority of India (FSSAI) - FSSAI regulations specifically cover aspects such as the design and construction of cold storage facilities, the transportation of dairy products, and the monitoring of temperature during storage and transportation. Bureau of Indian Standards (BIS) – Specifications for cold chain equipments like SS milk cans, milk storage tanks etc. Ministry of Food Processing Industries (MoFPI) – National cold chain policy to provide integrated cold chain and preservation infrastructure facilities. The CDSCO - regulations related to the packaging and labelling of dairy products. The FSSAI has issued a number of regulations related to cold chain management in the dairy industry. The following are some of the key regulations that apply to the dairy industry cold chain in India: FSSAI Regulation 2.2.2: This regulation requires dairy products to be stored and transported at a temperature that is appropriate for their type and shelf life. FSSAI Regulation 2.2.3: This regulation requires dairy product manufacturers to have a written cold chain management plan in place

Milk flow process from farm to fork



Cooling Systems usually used

Pre-cooling Systems: Rapid cooling methods used immediately after milk is collected from farms to lower its temperature quickly, preserving its freshness and inhibiting bacterial growth.

Solar-Powered Refrigeration: In regions with unreliable power supply or abundant solar energy availability, solar-powered refrigeration systems are used to maintain the cold chain without dependency on the electrical grid.

Thermal Blankets and Insulated Containers: These are used for short-distance transportation, providing additional insulation to keep dairy products at the desired temperature.

Bilk Milk Coolers: These are used at collection centers and dairy farms to cool raw milk rapidly to inhibit bacterial activity, extending its shelf life and maintaining quality.

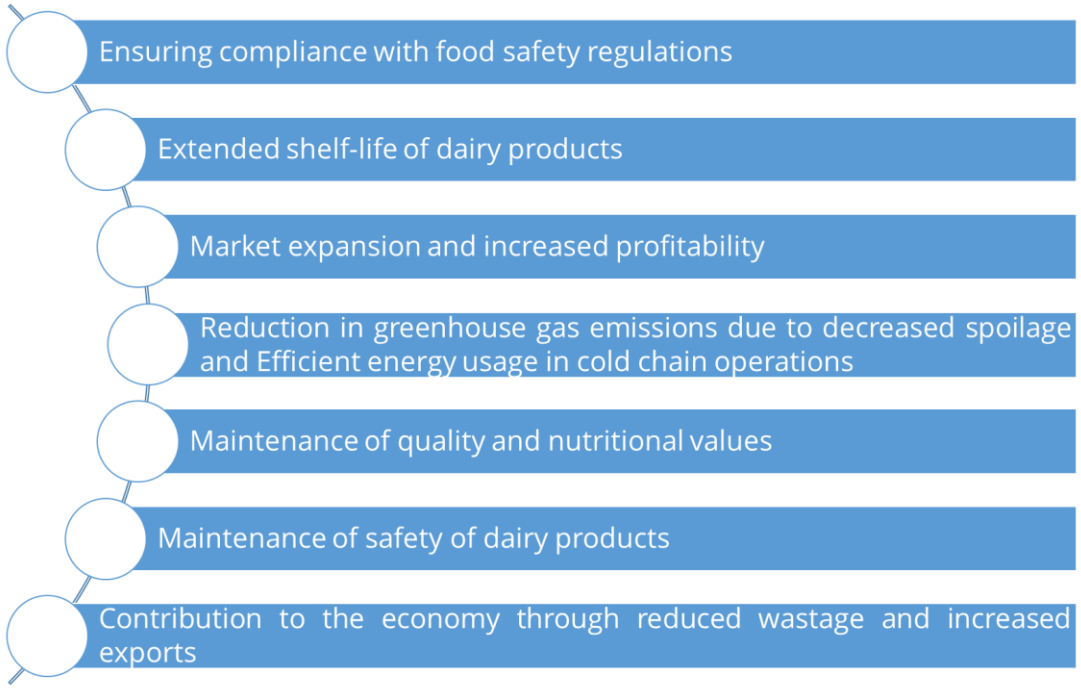
Refrigerated trucks and vans equipped with temperature control systems to maintain specific temperatures during transit.

Cold Storage Facilities with controlled temperature and humidity levels for storing bulk quantities of dairy products. These facilities are crucial for preserving the quality and extending the shelf life of perishable goods.

Bulk Milk Collection – Timing & Capacity

It is necessary to cool milk as soon as possible after the milking, the Bulk Milk Cooler (BMC) is used at collection centres for milk cooling and storage purpose. BMC is a very important component for cooling milk & storage until it reaches the main dairy plant by a milk tanker. BMCs are usually made of stainless steel and are used daily to store raw milk on farm or at milk collection centres in hygienic condition. BMCs gradually cools milk of 35˚C to 4˚C within a specified time limit. 2AII norms of ISO 5708 indicate that after normal milking, the BMC will cool down half the tank capacity of milk at 35˚C to 4˚C within 3 hours in each milking.

Benefits of Effective Cold Chain Management



Future Trends in Cold Chain Management

Adoption of advanced technologies (e.g., IoT, AI). The GOI is working to promote the use of new technologies to improve cold chain management. Blockchain technology: Blockchain technology can be used to track the movement of dairy products through the supply chain. This can help to ensure that the products are safe and that consumers can be confident about their provenance. Artificial intelligence (AI): AI can be used to develop predictive maintenance systems for cold chain equipment. This can help to reduce downtime and ensure that the equipment is always working properly. Internet of Things (IoT): IoT sensors can be used to monitor the temperature and humidity of cold chain facilities and vehicles. This information can be used to improve the efficiency of the cold chain and to prevent spoilage. For example: the FSSAI is exploring possibility of using next generation technological tools like blockchain and machine learning to ensure food safety and quality. FSSAI has undertaken a pilot project to use blockchain technology to track the movement of dairy products through the supply chain.

Oral Presentations

OS 1.1 Optimization of Recombined Milk Preparation Using a Custom Design Universal Disperser: Effects of Temperature and Impeller Speed

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The present work was undertaken to investigate the feasibility of a custom designed and fabricated universal disperser unit for the preparation of recombined milk. Water, SMP and butteroil were used to manufacture the recombined milk. Three levels of fat viz 1.5%, 3.0% and 4.5% were evaluated to study the effect of fat content on the recombination efficiency. In this research, two independent parameters, specifically temperature and impeller speed at three distinct levels were chosen for investigation. The specially designed impeller was employed to provide high shear action. The assessment of operation efficiency relied on various dependent parameters, including mixing time, mixing index, creaming index, power consumption, and overall acceptability. The experimental design was structured in accordance with Response Surface Methodology (RSM) using Design Expert V.10.0 software. The optimal combinations for the preparation of recombined milk were determined as follows: 1.5% fat RM (17,820 rpm, 48 °C), 3.0% fat RM (15,701 rpm, 48 °C), and 4.5% fat RM (15,459 rpm, 48 °C)

Keywords: Recombined milk, creaming index, universal disperser, mixing time etc.

OS 1.2 Development and Characterization of Corn Starch-based Nanocomposite Films with Aloe Vera Conjugated Silver Nanoparticles for Active packaging Applications

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Replacing packaging plastics with biodegradable active materials is an emerging concern. In this context, composite films using starch obtained from corn starch (CS) and varying concentration of aloe vera conjugated silver nanoparticles (*Al*AgNPs) were prepared by casting method. *Al*AgNPs thus produced were characterized using UV-V is spectroscopy, XRD and SEM. The UV-Vis spectral analysis identified a broad peak at approximately 400 nm, indicating the photosynthesis of *Al*AgNPs. The XRD patterns of *Al*AgNPs showed typical diffraction peaks at the (113), (111), and (200), demonstrating the face-centered cubic structure of crystalline metal *Al*AgNPs. The film thickness of native CS and CS with *Al*AgNP solution varied from 0.2 mm to 0.6 mm. *Al*AgNP solution in the CS matrix significantly altered the physical properties such as opacity, water vapor permeability mechanical property, solubility, and swelling index of the films. Inclusion of *Al*AgNPs pointedly enhanced the water vapor barrier and hydrophobicity of the composite films. However, adding *Al*AgNPs did not significantly affect the films mechanical strength and thermal stability. FTIR spectrum presented the improved intermolecular interaction between CS matrix and *Al*AgNPs. SEM images of nanocomposite films depicted a smooth, homogenous, and continuous surface without signs of phase separation among the CS matrix and *Al*AgNPs. The green *Al*AgNPs mixed corn starch based composite films with improved physical (mechanical strength, water vapor barrier) and functional properties (antibacterial activity) are expected to be utilized in active food packaging applications or maintaining the safety and extending the shelf life of packaged food.

Keywords: Corn starch, spectroscopy, packaging, water vapor permeability etc.

OS 1.3 Development and Testing of a Semi- Automatic *Dahi* Making Machine

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In this research work the designing was done on CAD to fabricate the prototype of a semi-automatic *dahi* (Curd) making machine with control facility for product and processing parameters. The performance evaluation and process parameters optimization in this machine for different varieties of Yogurt/ Dahi was successfully conducted. Practical utility of this developed system is that once this unit is loaded with pre-filled cups and switched on, the fully automatic *dahi* making machine would automatically control the temperature and pH all through during the incubation period and switch over from heating to cooling mode automatically and then would switch off automatically at the required low temperature. It would improve and ensure the consistent quality and also reduce the product formation time and handling cost. Thus, it would be proved very useful to the small entrepreneurs in dairy processing by giving them a convenient solution of *dahi* making directly in prefilled/ pre-packed cups. Further, automation in *dahi*/yogurt making will help in reducing the labour requirement as well as save the time and energy consumption. Standardization of *dahi*/yogurt making process achieved and experimentation were conducted for optimizing the incubation time & temperature, cooling time & temperature, final pH value of *dahi* and process energy consumption. Some of the main required materials used in the development of the semi-automatic *dahi* making machine were as follow: Insulated Cabinet of powder coated GI sheet with SS sheet inside finishing and 4 perforated trays and door with inbuilt double glass wall, Condensing unit chamber and Control Panel, Refrigerant Compressor, Finned tube type Condenser and Evaporator coils, Capillary tube, Pressure gauge-2 No.The developed prototype of *Dahi/ Yogurt* making machine is a fully automatic, very convenient, energy efficient, hygienic, fast and economic solution for making and selling required number of cups of good quality dahi with controllable process parameters. Expected Benefits and Economic Impact: Better profit for all the stakeholders involved in small scale yogurt/ dahi production and processing as product of better and consistent quality could be obtained in less time.

Keywords: Corn starch, spectroscopy, packaging, water vapor permeability etc.

OS 1.4 Design and Development of Continuous Ohmic Heating System for Standardize Milk

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Novel technology plays a pivotal role in driving innovation, solving complex problems, improving efficiency, promoting economic growth, and empowering individuals and communities. Ohmic heating allows precise control over temperature and heating rates which is beneficial for processing heat-sensitive products that requires gentle and consistent heating, such as in dairy and food product. The designed ohmic heater was optimized for heating of standardized milk to a temperature of up to 73°C. Performance was studied by observing temperature profile, current profile, system performance co-efficient, heating rate and power consumption. Efficient heating of milk was achieved by optimizing the heater with a voltage of 137.7 V (stage-1) and 72.2V (stage-2) and a flow rate of1.5 l/min. The average heating rate for milk was 4.6°C/min. At optimized conditions, system performance co-efficient was found to be 86.95 per cent for milk. The designed heater will help milk producers for uplifting socio-economic status. By harnessing the benefits of ohmic heating technology, milk processing can meet consumer demands while ensuring food safety.

Keywords: Ohmic heater, standardize milk, performance evaluation etc.

OS 1.5 Development of Thermo-mechanical Block Cutting Unit for Frozen Butter

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Dairy plants utilizing stored butter for ghee production and milk recombination regularly face the problem of melting the frozen (-20°C) butter blocks. The blocks require thawing and size reduction prior to melting that consumes 6-8 h. The present research was undertaken to develop thermo-mechanical unit cutting for size reduction of these blocks without thawing. Initially, the cutting-related properties of frozen butter were quantified as function of temperature and used to simulate thermo-mechanical cutting process using Computational Fluid Dynamics. APLC-based thermal and pneumatic control system consisting of thermocouples, ADC modules, thyristors, and solenoid valve was developed and installed with the unit. Performance of the developed unit was optimized using $2^2 \times 1^3$ full factorial design. On validation of the optimized process conditions, it was concluded that the developed unit can cut a frozen (-20°C) butter block in 12.09 min with energy consumption of 1388 kJ and without the need for thawing. If a thawed(10°C) butter block is fed, the unit can cut in 5.56 min with energy consumption of 1073 kJ. The unit is easily scalable to the required capacity for industrial adoption.

Keywords: Computational Fluid Dynamics, thermo-mechanical, energy consumption etc.

OS 1.6 Design and Fabrication of Pulsed Electric Field Applicator for Treatment of Milk

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A lab scale batch type PEF applicator was designed with the capability to generate voltage in the range of 20-60 kV. Based on preliminary trials, voltage (35-55 kV), time (30-60 s), frequency (90 Hz) and pulse width (900µs) were identified as process parameters. The effect of PEF treatment on the microbial, physico-chemical and sensory quality attributes of treated milk was evaluated. Response Surface Methodology (RSM) was employed to analyze the data. The results showed no significant effect of PEF treatment on pH, acidity, ash content, protein, FFA and overall acceptability of milk. A combination of 55 kV voltage for 50 s was found to be the optimal combination of process parameters to maximize the reduction in total bacterial count (TBC) of raw milk. A 90% reduction in bacterial count was predicted and validated with real time experiment in the study. Double pass PEF treatment was found to be more effective than single pass treatment. PEF treated milk kept well for 11 h as compared to pasteurized milk (13 h) at ambient temperature. Under refrigerated storage, the keeping quality of raw milk, PEF treated milk and pasteurized milk was 10 h, 35 h and 55 h respectively.

Keywords: Computational Fluid Dynamics, thermo-mechanical, energy consumption etc.

OS 2.1 Scraper-Surface Isothermal Bioreactor for Improved Biogas Production

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This research explores the development of an isothermal bioreactor that aims to address limitations observed in traditional biogas reactors. The study involves the development of a 45 L scrapped surface isothermal bioreactor based on engineering design and principles. Stress analysis of the bioreactor's components reveals a maximum blade deformation of 3 mm, an equivalent stress of 242 MPa, and a safety factor of 1.2. Furthermore, fatigue analysis predicts a blade lifespan of 6.6×10^5 cycles, underscoring its robustness and durability. To gain insights into temperature and velocity distributions within the bioreactor, Computational Fluid Dynamics (CFD) simulations are utilized. These simulations effectively estimate the time required to attain optimal biogas generation temperatures, with a computed duration of 15 minutes at 40°C. The credibility of the simulated temperature profiles is substantiated through validation procedures employing Root Mean Square Error (RMSE) and the percent mean relative deviation modulus. Utilizing the Taguchi orthogonal array approach, the study identifies optimal conditions for the co-digestion process involving whey. The optimized parameters encompass a slurry temperature of 40°C, a whey to slurry ratio of 10:90, and a mixing frequency of 4 times per day. In conclusion, the isothermal bioreactor presents a viable solution for overcoming challenges associated with traditional biogas reactors, thus enhancing overall performance and efficiency.

Keywords: Computational Fluid Dynamics, thermo-mechanical, energy consumption etc.

OS 2.2 Energy Requirements for Manufacture of *Dhap Khoa* using Three-Stage Scraped Surface Heat Exchanger

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Energy requirement of three-stage scraped surface heat exchanger (TS-SSHE) for manufacture of *dhap khoa* was investigated in terms of steam energy, electrical energy and steam economy. *Khoa* is heat desiccated milk product which is classified into *pindi*, *danedar* and *dhap types. Dhap khoa* is characterized by a loose, sticky body and smooth texture. It has higher moisture content than *pindi* or *danedar* type. Steam pressure for first and second stage was kept constant as 3.5kg/cm^2 and 1.5kg/cm^2, respectively. Scrapper speed for first and second stage was fixed at 200 rpm 150rpm, respectively. Experimental trials were conducted on three independent parameters of TS-SSHE i.e., scrapper speed and steam pressure of third stage and milk flow rate. For third stage of TS-SSHE, scrapper speed varied from 15 to 35 rpm whereas steam pressure varied from 1 to 1.5 kg/cm^2. Milk flow rate varied from 200 to 225 kg/h. Steam energy requirement was 1805.89 to 2435.09 kJ per kg of milk processed with average value 2152.184 kJ per kg of milk processed. Electricity consumption was in range of 5.87 to 6.75 kWh per 1000 kg of milk processed with average value of 6.30 kWh per 1000 kg of milk processed.

Keywords: Dhap *Khoa*, Three-Stage Scraped Surface Heat Exchanger, steam economy etc.

OS 2.3 Design and Validation of Multi-Modular Anaerobic Digester for Cow Manure Co-Digestion

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Anaerobic co-digestion (AcoD) involves the simultaneous breakdown of diverse organic wastes in a single digester to achieve a desired carbon-to-nitrogen (C/N) ratio. Maintaining the optimal C/N ratio of 15 to 30 for cow manure is essential, given its wide acceptance in waste management, energy generation (biogas), and nutrient recovery (digestate). Co-digestion yields advantages such as enhanced system stability, increased methane production, balanced nutrient composition, and production of safe, high-quality digestate suitable for agriculture. The anaerobic digester comprises 9 modules, each with a 1-litre capacity, totaling 9 liters, and includes continuous pH and temperature monitoring for optimal conditions. Mesophilic conditions were employed for the experiment, using whey as a co-substrate with cow manure. Digester efficiency was assessed based on methane yield and volatile solids (VS) reduction, comparing results with literature and a 45-litre isothermal anaerobic digester. Methane production varied by about 10%, with no discernible difference in VS reduction between the two setups. The multi-modular digester's versatility, allowing concurrent use of diverse co-substrates across varying concentrations in 9 modules, holds potential for research labs, offering savings in time, resources, and labour.

Keywords: Computational Fluid Dynamics, thermo-mechanical, energy consumption etc.

OS 2.4 Design and Development of Solar Thermal System Assisted Incubation Room for Sustainable Dairying

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Incubation at proper temperature is a mandatory step in the manufacture of fermented dairy and food products. The basic aim of the project was to design and develop a solar based incubation room to maintain desired temperature using solar thermal system in order to replace electrical air heaters which are traditionally used in dairy and food plants. The use of solar thermal energy not only helps in reducing the cost of energy but also contributes in combating adverse effect on environment. An experimental solar based incubation room having storage capacity of 100 crates was designed for the incubation conditions required for the manufacture of dairy and food products. The system was equipped with hot water generation, storage, circulating pumps, instruments and controls. The performance of the system was evaluated in terms of solar fraction throughout the year.

Keywords: Computational Fluid Dynamics, thermo-mechanical, energy consumption etc.

OS 2.5 An Analysis of Effluent Foot Printing of Milk Processing Industry in Punjab

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An essential challenge of water resource sustainability is the available fresh water demand of a growing population. Given their high organic content and huge wastewater discharges, dairy sector wastewater treatment plants have been identified as a major polluter. Present study was conducted with an objective to analyze the waste water footprint of milk processing in selected dairy plants in the state. Total nine milk processing plants were selected for study and data pertaining to installed milk processing capacity, milk handling and products profile, water, energy utilization and effluent generated of each dairy plant for five years (2015-2019) was collected. It was found that 2.59 liters effluent was generated for every one kg of milk processed in the state. For better depiction of water uses in milk processing, dairy plants were further classified into plant with or without milk drying facility and it was found that the milk plants with drying facility had higher effluent footprint compared to plants without milk drying facility. As Dairy industries have an enormous effect on water pollution, suitable wastewater treatment methods are required to use for water conservation in dairy sector.

Keywords: Effluent footprint, milk processing, dairy products, SDG12 etc.

OS 2.6 Heat Transfer Modelling of *Gulabjamun* Frying Using Computational Food Dynamics

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Gulabjamun is a traditional Indian Dairy Product which is popular across the entire country. However, its production is mostly done at small scale by unorganized dairies due to the lack of process equipment available for its production. Mathematical modelling and simulation using computation al fluid dynamics (CFD) can be a useful tool for optimizing the process parameters and for equipment design. It can be seen as a useful tool to help optimize the process and processing equipment for continuous large-scale production. Simulation was done using ANSYS R15.0 software to study the temperature distribution across the *gulabjamun* ball during frying at different temperatures. Thermal conductivity and specific heat of ghee varied from 0.449-8.34 W/mK and 0.491-0.835 J/kgK, at different temperature respectively. Core temperature, weight gain and volume change of the balls after frying were studied. Validation of the simulated results was done by frying experiments at 120, 130 and 140 °C with two different time combinations i.e., 10 and 20 min. The core temperature predicted by the simulation studies (100.4 °C) correlated well with the experimental results (100 °C), which validated the simulation studies. Thus, CFD can be used as a powerful tool to simulate processes in the food industry.

Keywords: *Gulabjamun*, core temperature, mathematical modelling etc.

OS 3.1 Machine Vision System to Measure Temperature Dependent Colour Properties of *Ghee*

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Colour conveys information to the consumer about product's sensory qualities. Colour measuring instruments are commonly employed for objective quantification of colour and variation from observer to observer can be avoided. India as a country has wide temperature variation round the year. Temperature based colour profiling of ghee will help to quantify such changes. Lab colour scale, Whiteness Index, and Yellowness Index, out of 10 various scales and colour indices, produced the most significant findings for characterizing the ghee sample at temperatures between -18^{o}C and 50^{o}C. It is required for dairy products like ghee which have temperature dependent state properties. Integrated system of reflection and transmission that can help in better quantification of colorimetric properties. The majority of colour measuring instruments and computer vision systems do not have a temperature control mechanism. It is required for dairy products with temperature-dependent state properties, such as ghee. There is need to explore other colour scales which may give better quantification of colorimetric properties. CIE lab is the most widely used scale for colour measurement applications.

Keywords: Colour, Colorimetry, Machine vision, Colour Scale, *Ghee*, thermal integration etc.

OS 3.2 Vacuum Frying of *Gulabjamun*: Process Optimization, Heat and Mass transfer Modeling using Finite Element Method

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Gulabjamun is a delicious dairy based dessert item. It is popular not only the Indian subcontinent but also all over the globe. Currently, people are increasingly health conscious and inclined towards adopting diets with low oil content for better well-being. Vacuum frying is an alternative method for conventional atmospheric deep fat frying which produces low fat products with health benefits. Thus, the study deals with the vacuum frying of *Gulabjamun* at different process conditions to investigate moisture loss, oil uptake, water activity, size of product, color, texture, and structure. *Gulabjamun* balls are fried at different vacuum conditions of 15, 20 and 25 cm Hg from atmospheric pressure conditions and different frying temperatures (125°C, 135°C and 145°C) with varying time from 8 min to 12 min. The statistical optimization was carried out and the optimized process condition was modelled using finite element technique. The comparison between predicted and observed results showed that the model successfully simulated the batch type vacuum frying processes for *Gulabjamun*. The resulted *Gulabjamun* obtained adopting the optimized frying conditions was having less fat content with highly sensory acceptable, better color, texture, and was having characteristic internal and external structural attributes in comparison to any traditional quality *Gulabjamun*.

Keywords: *Gulabjamun*, Vacuum frying, Finite element modelling, Low fat food, etc.

OS 3.3 Quality Prediction During Storage of Dairy Yogurt Using Artificial Neural Network Modelling

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Changes in the physicochemical structure of yogurt determines the quality during storage of the yogurt. In this study acidity, pH, color values were determined for 30 days and texture was determined at 1,8,15,22 and 29 days. Obtained data were modeled with artificial neural network (ANN) to predict the physicochemical quality characteristics of whole milk yogurt. Total four ANN models were developed using back-propagation networks with different inputs variables such as acidity and pH, texture and color values to predict the physicochemical quality characteristics during storage. The modeling results while using acidity-pH as input variables and texture, color and shelf life as output variable showed excellent agreement between the experimental data and predicted values, with a high regression (R = 0.99829) showing that the developed model was able to analyze nonlinear multivariant data with very good performance, fewer parameters, and shorter calculation time. The model might be an alternative method to control the expiration date of yogurt shown in labeling and provide consumers with a safer food supply.

Keywords: artificial neural network, yogurt, physicochemical characteristics prediction etc.

OS 3.4 Sorption Properties of In-package Microwave Treated *Paneer* by using DVS Method

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The moisture sorption isotherm and isosteric heat of sorption for in-package microwave treated *paneer* at 20, 30 and 40^{o}C were obtained by relating the equilibrium moisture content (EMC) and water activity (a_w). Dynamic Vapor Sorption (DVS) method was used between 0.0 to 1.0 water activities for sorption isotherm which were found as Type-III, J-shape. The EMC at 20^{o}C was observed higher than that at 30 and 40^{o}C. Eleven mathematical sorption models were applied for fitting of experimental sorption data generated for in-package microwave-treated *paneer*. Nonlinear curve fit feature of DVS Intrinsic Advance Suite 2.0 was used to fit the sorption data for adsorption curve sat each of three temperatures. Among eleven mathematical models, Oswin, GAB and Modified Mizrahi models were found to be in good agreement. The Oswin model was found to be the best fit for the sorption data at all three temperatures (R^2 = 0.90-0.99; %P-value=1.91-7.47) for the treated *paneer*. The isostreic heat of sorption, a thermodynamic property of the product, was determined as function of product moisture content. The highest possible isosteric heat of sorption of in-package microwave-treated *paneer* was found to be67.67 kJ/mol at 4% moisture(db).

Keywords: Moisture sorption isotherm, *paneer*, isosteric heat, DVS, water activity etc.

OS 3.5 Studies on Hold up Volume of Three Stage Scraped Surface Heat Exchanger

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Scraped Surface Heat Exchangers (SSHEs) are widely used in dairy and food industry for the processing of viscous dairy and food products. However, their complex geometry and the presence of seals for the rotating shaft, the food product entry and exit as well as the blade shaft connections make cleaning difficult. The fluid is subjected to a high friction force inside the SSHE itself due to the mixing provided by the scraping blades, inducing fluid stagnation, due to the weakness of flow dynamics in closed areas. The experiments were conducted to determine the hold-up volume for three stage SSHE at fixed operating parameters i.e., steam pressure and scraper speed at different stages (3.5 kgf/cm^2 and 200 rpm for first stage; 2.5kgf/cm^2 and 175 rpm second stage and 1.0 kgf/cm^{2}and 40 rpm for third stage of SSHE) for 350 to 528 kg/h flow rate of water as a process fluid. The hold-up volume for TSSSHE was 45.90 litre at the volumetric flow rate 9.18 litre/minlitres by keeping the parameters fixed i.e., scraper speed 200rpm, flow rate 528 kg/h and steam pressure utilized washigher value for first stage followed by lowest value for third stage and subsequently intermediate value for second stage respectively.

Keywords: Scraped Surface Heat Exchangers, scraping blades, flow rate etc.

OS 3.6 Performance Evaluation of Grid-connected Roof Top Solar PV System

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In Indian solar market, standard ranking of solar radiation databases is not available therefore project developers adopt the solar radiation databases randomly. It was also reported that all the database either overestimate or underestimate the performance of Select PV (SPV) projects. The aim of the present study was to evaluate the performance of rooftop SPV in local weather conditions of Anand city of Gujarat state. Polycrystalline based fixed ballast rooftop SPV of 12 kWp capacity installed at workshop building of dairy engineering department of Dairy Science College, Anand was considered. Various weather parameters affecting the performance of SPV in different months of the year were recorded and performance evaluation of the system was carried out. The average daily energy yield per kWp of SPV was 42 kWh over a year. The maximum monthly energy yield was 1780.22 kWh in May. The minimum monthly energy yield was 998.97 kWh in August. The variation in performance was due to daily and seasonal variations in weather parameters. These data can be useful for accurate selection of size of SPV required to meet yearly electricity demand for a given application. At the same time, it avoids unnecessary overdesign of size of SPV and hence the investments.

Keywords: SPV rooftops, solar radiations, energy yield etc.

OS 4.1 Interactive Effects of Axial Fan Speed and Geometrical Configuration on the Freezing Process in Household Refrigerator

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The process of freezing entails reducing the product's temperature to the point where ice crystals begin to form within the product's structure which facilitates the preservation of food. The technique aims to reduce the product's temperature to the greatest extent as is physically feasible in an attempt to increase the shelf life of the food. Knowledge is needed to effectively develop the process to reduce the freezing time and energy, which will give further benefits over various goods. In our investigation, two distinct axial fan orientations aligned with the air duct and perpendicular to the air duct in a household refrigerator was assessed and compared to the traditional approach in their absence. Several sensors were used to identify fast and slow cooling regions as well as the freezing front and temperature fluctuations inside the mould matrix. Temperature gradient, temperature profile, cooling rate, and cooling duration were all considered while analyzing cooling performance. The research suggested using a timer circuit to manage axial fan functioning and a speed regulator to avoid interrupting the typical control sequence for the freezer. The results provide us with useful information about the impact of implementing an axial fan in a domestic freezer to get benefits comparable to those of an air blast freezer at home.

Keywords: artificial neural network, yogurt, physicochemical characteristics prediction.

OS 4.2 Assessment of the Raw Milk Quality Supplied by Local Vendors to Sweet Shops in the Manjhi Block of Saran District

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Milk plays a crucial role in the daily nutritional needs of pregnant women and growing children due to its unique nutritional content and its significant impact on human health. Unfortunately, there is a prevalent issue of milk adulteration, where cost-effective substitutes are often used or false claims of higher quality are made. Detecting such adulteration is a widespread concern in various regions, and it can be addressed using rapid milk adulteration testing kits. This study, conducted in the Manjhi block of Saran district, utilized a milk adulteration kit developed by ICAR-NDRI, Karnal, and supplied by Delmos Research Pvt. Ltd., Karnal. Ten sweet shops, each collecting 50 liters of milk per day, were selected for the investigation. Out of the 40 samples examined, all passed the urea and sucrose tests, indicating an absence of adulteration with these substances. However, it was discovered that eight samples had been contaminated with formalin, particularly during the summer months. This underscores the need for maintaining cleanliness and safety throughout the milk production process. To address this issue, there is a growing demand for affordable and user-friendly milk cooling devices tailored to the needs of small-scale vendors. Furthermore, individuals involved in any aspect of milk production, sale, or processing should receive adequate training and education to prevent such problems from occurring in the future.

Keywords: Artificial neural network, yogurt, physicochemical characteristics prediction etc.

OS 4.3 Using Vacuum for milk cooling at farm level

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On farm cooling of milk is of utmost importance. The department has earlier developed the milk chilling technology based on phase changing material, thus using the power of latent heat of substance to cool the milk. The milk chilling achieved using PCM material was as good as with any other conventional method using vapour compression systems. The recent focus on phasing out the environmentally harm refrigerant and sue of green refrigerants forced to think of the method where chilling can be achieved using vacuum pumps only. The experiment was so designed that the outer cavity of the milk holding cavity can be used to produce refrigerant effect to cool the milk. The study has shown that by using only vacuum pump the lowest temperature achieved was 12^{o}C within the one hour of operation.

Keywords: milk, milk chiller, milk cooling etc.

OS 4.4 Integration of Thermal Energy Storage Systems for Enhanced Sustainability in Dairy Industries

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The dairy industry relies heavily on thermal energy for various processes, including milk production, pasteurization, and refrigeration. Harnessing solar thermal energy and implementing advanced thermal energy storage systems can significantly enhance the sustainability and energy efficiency of dairy operations. This article explores the integration of thermal energy storage systems, including ice bank tanks, glycol-based ice storage, falling film ice chillers, and phase change materials (PCMs), into the dairy industry. It reviews the current thermal requirements of dairy processes, investigates the potential of solar thermal systems, recommends integration strategies, and calculates the Levelized Cost of Heat (LCOH) to evaluate the economic feasibility. The adoption of these technologies can reduce energy costs, improve energy system reliability, and contribute to a more sustainable dairy industry.

Keywords: thermal energy, phase change materials, sustainability in dairy industry etc.

OS 4.5 Energy analysis of a two-stage spray drying plant

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Milk is a highly perishable commodity; therefore, it is mostly converted into more stable products such as skim milk powder etc. Skim milk powder is mostly produced by spray drying, which is a highly energy intensive process. Energy analysis is necessary for energy conservation as well as for determining efficiency of different components for spray drying plants, so that the least efficient component may be ascertained. For this study, input data were collected and utilized to analyse the energetic parameters of selected two-stage spray drying plant and the components, having the most scope of improvement, were selected. For this spray drying plant, the decreasing order of energy improvement potential values (kJ/kg) were drying chamber > VFBD (Vibratory Fluidised Bed Dryer) > homogeniser > tubular preheater > booster pump > cyclone separator > concentrate vat. The energy improvement potential was highest for drying chamber, followed by VFBD. Energy destroyed (loss) was highest for drying chamber. Energetic factor was highest for drying chamber. This analysis provided energy efficiency of different components for the spray drying plants along with the least efficient component, which was VFBD.

Keywords: Exergoeconomic, cyclone separator, Vibratory Fluidized Bed Dryer etc.

OS 5.1 Development of Extraction Method for Simultaneous Detection of Tetracyclines in *Khoa* by RP-HPLC Method

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Present study was conducted to optimize the RP-HPLC conditions and to develop an extraction method for simultaneous detection of Oxytetracycline (OTC), Tetracycline (TC), and Chlortetracycline (CTC) in Khoa. A trial-and-error approach was employed for optimization of RP-HPLC conditions and involved adjustment in various parameters such as mobile phase composition, flow rate, column temperature, and detector wavelength. After trials with different ratios of three mobile phases viz., 0.01 M oxalic acid, acetonitrile and methanol at different flow rates, a reverse phase - gradient flow method with 0.5 ml/minute flow rate and detector wavelength of 355 nm was developed. These conditions gave well isolated peaks of OTC, TC and CTC at retention times of 15.8, 16.9 and 21.2 minutes, respectively. Calibration curve with correlation coefficient >0.99 was obtained using standard solutions of antibiotic mix containing 0.05, 0.10, 0.25, 0.50, 0.75 and 1.00 mg/kg of each of the OTC, TC, and CTC. Further, an extraction method was developed for efficient recovery of OTC, TC, and CTC from Khoa samples spiked with antibiotic mix at six concentrations viz., 0.05, 0.10, 0.25, 0.50, 0.75 and 1.00 mg/kg. Different extraction strategies and sample pre-treatment techniques were evaluated and a solid phase extraction (SPE) method was developed with following steps – protein digestion, buffer addition, centrifugation, SPE cartridges elution, evaporation and reconstitution in methanol for simultaneous extraction of OTC, TC and CTC from khoa by RP-HPLC with 87.9, 87.4 and 86.7% recoveries, respectively.

Keywords: *Khoa*, tetracycline, evaluation of different samples, solid phase extraction etc.

OS 5.2 Characterization of Bio-nanocomposite Films and their Impact on Quality Attributes of Perishable *Paneer*

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The current investigation aimed to characterize bio-nanocomposite films based on starch for the packaging of perishable goods. The impact of nanofillers such as montmorillonite (MMT), starch nanocrystals (SNCs) and lemongrass oil nanoemulsion (LNE) were investigated to assess their effects on the mechanical, barrier, microbiological and biodegradable characteristics of the developed bio-nanocomposite films. These films may offer an eco-friendly substitute for conventional plastic packaging. Paneer cubes were packed in the films composed of whole corn starch, corn starch with SNCs (1%)/LNE (2%) and MMT (1.5%)/LNE (2%) along with uncoated cubes of paneer as control and to evaluate their impact on the quality attributes of paneer during storage at 4ºC. In paneer storage study, MMT/LNE bio-nanocomposites showed minimal changes in physicochemical and microbiological properties, maintaining texture, tyrosine value (25.34 mg/100g), and free acid fatty value (0.6 µm/g) for 12 days. This was due to their low water vapor transmission rate (0.1836 g/h.cm2). Both MMT/LNE and SNCs/LNE bio-nanocomposites extended paneer shelf life to 12 days, while non-packaged and corn starch film-packaged paneer remained good for consumption for 4 and 8 days at 4°C, respectively. Therefore, bio-nanocomposite films could be utilized as an active packaging to extend the shelf life of perishable dairy product.

Keywords: *Paneer*; Starch; Bio-nanocomposite; Packaging film etc.

OS 5.3 Spray and Freeze Drying for Viability Enhancement of Probiotic Culture-*Lacticaseibacillus rhamnosus*

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Probiotics like *L. rhamnosus*are live microorganisms that help to maintain the natural balance of microflora in the intestine and are commercially marketed across the world. Spray and freeze-drying techniques are usually adopted for its encapsulation. During freeze drying, the wall materials along with bacteria were initially frozen to -80°C and then dried for 18-20 h (0.002 mbar). In spray drying, the inlet and outlet temperatures of air were 170 and 70°C, respectively. After 45 days of storage at -18°C, the freeze-dried encapsulate of containing 30% iso-malto oligosaccharide (IMO) and 20% myo-inositol had a viability of 8.2 log CFU/g, whereas spray-dried encapsulate showed viability of 7.83 log CFU/g. The lowest cell death rate and highest storage stability of *L. rhamnosus* were obtained in the encapsulates spray- and freeze-dried with 30% IMO along with 20% WPI and 20% myo-inositol, respectively. The highest survival rate of 90.8 and 86.73% were obtained for freeze and spray drying, respectively. The encapsulated *L. rhamnosus* showed viable count of >8 log CFU/g at simulated gastrointestinal (GI) conditions. It is concluded that the freeze-drying technique is better for the encapsulation of probiotic culture to enhance the survival rate and improve the GI tract than spray drying.

Keywords: Probiotics, spray drying encapsulation, L. *rhamnosus* etc.

OS 5.4 Novel Bio-based Nutritional and Functional Mango Juice Enriched with *Lactobacillus acidophilus*

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The study aimed to enhance and upgrade existing technology on a pilot scale, focusing on the microbiological, biochemical, and sensory evaluation of probiotic mango juice produced in the pilot plant. *Lactobacillus acidophilus* (MTCC 10307) probiotic culture was incorporated into mango juice at an initial concentration of 10^8 CFU/ml. Over a six-week period, we monitored probiotic viability, titrable acidity, pH, total sugars, TSS (Total Soluble Solids), reducing and non-reducing sugars, antioxidant activity, Vitamin C content, lactic acid levels, and microbial contaminants in the newly developed probiotic juice on a weekly basis. Probiotic viability remained consistently above 8 log CFU/ml for up to 28 days in the pilot plant-produced probiotic mango juice. Total plate count, yeast and mold count, and coliform count remained within acceptable limits during the first four weeks of storage at 4°C. The average sensory score for the acceptability of the developed probiotic mango juice was 8.03. Technological viability assessment indicated a production cost of Rs 135/- for 1 liter of probiotic mango juice.Considering the significant probiotic viability (10^8 CFU/ml) up to 4 weeks of storage, this fruit-based probiotic beverage holds promise as an appealing choice for consumers of various age groups. The developed method for preparing probiotic mango juice is economically feasible and has the potential for industrial exploitation.

Keywords: *Lactobacillus acidophilus*, Mango juice, Probiotic viability, Technological viability etc.

OS 5.5 Development and Characterization of Cellulose Nanofibrils (CNFs) from Rice Straw as Reinforcing Materials for Bio-based Composite films

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The current study aims to separate cellulose fibers from rice straw (RS) and develop, characterization of cellulose nanofibrils (CNFs)for application in polymer-based composite films as reinforcing materials. Pulping and bleaching of RS were performed using an organosolv pulping (Formic acid: Acetone: 8:2) at 106℃, and 68% chemical doses for 270 min and DED (D: chlorine dioxide bleaching2.5%, 1.5%, E: NaOH extraction 3%) bleaching sequence. As a result, a significant increase in cellulose by 90.50%, and a reduction of Kalson lignin from 17.50% to 1.9%, for bleached pulp. The development of CNFs was performed with the help of a laboratory valley beater and ultrasonic probe sonicator. The average diameters of developed CNFs were less the 100nm shown by the SEM analyzer. The particle size distribution bythe DLS analyzer also confirms that particles are less than 100 nm and the average particle size is in the range of 150-160 nm. FTIR and XRD results also confirm the removal of hemicellulose and lignin for the developed CNFs and increase in crystallinity approximately to75%. The developed CNFs can be used as a reinforcing material for bio-based polymer-composite films with high mechanical, barrier, and thermal stability and that bio composite films can be used as a functional packaging application.

Keywords: Characterization, cellulose fibers, rice straw, ultrasonic etc.

OS 5.6 RP-HPLC Method Development – An Intervention to Check Quality of *Dahi* by Estimation of Antibiotic Residues

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The antibiotic residues in milk or milk products pose serious health concerns such as antibiotic resistance and therefore their estimation is of utmost importance. The present study was carried out to develop and validate RP-HPLC method for detection of oxytetracycline (OTC) residues in d*ahi*. The method development included optimization of chromatographic conditions and determination of validation parameters like linearity, accuracy, specificity, limit of detection (LOD) and limit of quantitation (LOQ) as per international guidelines (ICH Guidelines). The HPLC analysis was carried out using C18 reversed phase column (4.6 mm x 150 mm, porosity 5 µm) with isocratic flow using 0.01M oxalic acid and, mixture of methanol and acetonitrile (40:60) in 65:35 as mobile phase. The detection wavelength was 355 nm and the flow rate was standardized to 0.75 ml/minute. Linearity of the method was examined overconcentration range of 50- 1000 ηg/g for OTC. The correlation coefficient (r^2) was found to be > 0.99. The accuracy of the developed method was in the range 83.58-94.92 %. The validated method showed good specificity for OTC. The LOD and LOQ of developed method were 0.48 and 1.59ηg/g respectively, which were much lower than the Maximum residue limit (MRL) for oxytetracycline in milk and milk products specified by FSSAI i.e., 100 ηg/g.

Keywords: Antibiotic Residues, Maximum residue limit, correlation coefficient, oxytetracycline etc.

OS 6.1 Assessing the Influence of Ultrasonication Pre-treatment on the Engineering Properties of Biodegradable Cups

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The widespread use of petroleum-based plastic packaging materials, particularly single-use cups and containers made from polystyrene, commonly employed in the dairy and food industries, poses a significant environmental challenge due to their slow degradation in soil, leading to environmental pollution. Although there have been several efforts to create biodegradable films, relatively little attention has been given to producing sturdy containers from these biodegradable materials. To enhance the mechanical strength and overall suitability of these biodegradable packaging materials for industrial applications, it is imperative to improve their properties through innovative technological approaches. One such promising technology is ultrasonication, which has been documented as a successful method for enhancing various properties. This study focuses on the development of biodegradable cups using ultrasonication treatment. Ultrasonication treatment, with varying amplitudes (ranging from 20% to 60%) and durations (from 1 to 16 minutes), was employed to assess the impact on various properties of biodegradable cups crafted from a combination of corn starch, whey protein concentrate, carboxymethyl cellulose, and glycerol. The results indicate significant enhancements in mechanical properties, including tensile strength (measuring 3.204 ± 0.287 kgf) and puncture strength (1754 ± 150.58 gf), as well as a decrease in essential properties like water vapor permeability (measuring 0.76 ± 0.0031 g/m²/h) and moisture absorption (8.96 ± 0.65%) when compared to non-ultrasonicated samples. This technique shows promise for advancing the development of biodegradable cups.

Keywords: biodegradability, corn starch, whey protein concentrate, biodegradable cup, scanning electron microscopy, tensile strength etc.

OS 6.2 Process Optimization of Dean flow UV-C system for Whole Milk Processing

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With the growing consumer demand for minimally processed foods, UV-C technologies have gained significant attention due to their efficiency and sustainability, despite its challenges of limited penetration inside the opaque fluids. The Dean flow has proven to be an effective design for UV-C processing of opaque food products. This design utilizes a serpentine path to induce additional turbulence, ensuring uniform dose delivery. In this study, whole milk was processed through Dean flow UV-C system (254 nm) at 45, 90, and 180 L/hr. Practical and theoretical reduction equivalent fluence (REF), REF/second, Dean number, and electrical energy per order (E_{EO}) were evaluated for each flow rate. At 45, 90, and 180 L/hr., obtained REF values were 26±1.07, 14.5±0.53, and 10±0.27 mJ/cm², respectively. Corresponding Dean numbers were 646, 1292, and 2585, and E_{EO} values were 3.27, 2.94, and 2.67. The highest REF was achieved at 45 L/hr. due to the higher residence time. However, REF/second at 180 L/hr. was observed to be 1.54 and 1.38 times higher than at 45 and 90 L/hr., demonstrating superior dose delivery efficiency. No significant ($p>0.05$) difference in practical and theoretical REF was observed at 180 L/hr. Overall, the energy and dose delivery efficiency were greatest at 180 L/hr., attributed to the high Dean number ensuring uniform dose delivery. Therefore, for the current reactor geometry, a flow rate of 180 L/hr. emerges as the most efficient for milk processing. This study highlights the importance of optimizing processing conditions for UV-C processing of dairy products.

Keywords: UV-C technologies, milk processing, dose delivery etc.

OS 6.3 Formulation of Ricotta Cheese Spread with Reduced Fat: From Waste to Wealth

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Whey is the by-product obtained from cheese industries is highly rich in nutritional value but considered as one of the major dairy waste with BOD more than 35,000 mg/L. There is a great opportunity to convert this waste into some value-added products and whey cheeses hold great potential. Ricotta cheese is one of most popular whey cheese obtained by acid-heat precipitation of whey-milk mixture followed by whey removal which is also called scotta. This study include the conversion of ricotta cheese into spread with combined effect of makeup water, salt and guar gum followed by blending with the help of hand blender to achieve spreadable consistency. Mixed milk with fat percentage viz. 0.1, 1.5, 3.0 and 4.5% was added to whey at 20:80 ratios. The developed Ricotta cheese spreads (RCS) were studied for physico-chemical, compositional, solids recoveries, textural, rheological and sensory properties. Results showed that addition of guar gum and fat reduction in RCS significantly affecting the above measured properties of RCS. Sensory analysis revealed that RCS prepared with milk having 0.1% and 1.5%, were found to be highly acceptable might due to presence guar gum which is acting as fat replacer by increasing the water holding capacity. Fat reduction significantly affecting the composition of Scotta as well as losses occurred in scotta. Scotta can also further utilized in the preparation of Scotta based beverages.

Keywords: Waste utilization, Ricotta cheese spread, Guar gum, Scotta etc.

OS 6.3 Effect of Micro Nano Bubbles on the Rheological Properties of Stirred Yoghurt

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Stirred yoghurt is a type of yoghurt prepared by gentle stirring of the soft milk gel formed during the fermentation process. Micro Nano Bubbles (MNBs) is an emerging research area that offers a wide range of applications across disciplines of science and engineering including in food processing. The present study was conducted with an objective to study the effect of MNBs incorporation on the rheological properties of stirred yoghurt. Samples were prepared following the standard protocol of yoghurt preparation as prescribed by Lee et al., 2010 using standardized milk (4.5% milk fat and 8.5% MSNF) and non-dairy ingredients (sugar and stabilizer i.e., pectin). Food grade CO_2 gas was used for MNBs preparation into standardized milk for experimental samples and control sample was prepared without MNBs incorporation into milk. Rheological study was conducted using Physica MCR 101 rheometer (Anton Paar) attached with a cone and plate geometry (50 mm in diameter, cone angle of 1^o, gap of 0.099 mm)., and samples were subjected to different sweep tests viz., shear rate sweep, amplitude sweep and frequency sweep test. It is evident from the results that both control and experimental samples exhibited viscoelastic behaviour however, MNBs incorporated samples had higher apparent viscosity as compared to the control sample, which may be attributed to protein-polysaccharide interactions between cationic protein (casein micelles) at the bubble interface. Further, the amplitude sweeps test revealed that both the samples clearly show G'>G" and the crossover point (G'=G'') for the control sample was lower than the experimental sample, with MNBs depicting higher resistance to flow by the experimental sample as compared to the control. The MNB treatment has the potential to be applied as a new processing tool to easily tweak the viscosity of the stirred yoghurt as per the requirements of the product to meet the consumer demand for products with variable consistency and functionality.

Keywords: Micro-Nano-Bubbles, rheology, stirred yoghurt, viscoelastic etc.

Posters

PS 1.1 Hydrodynamic Cavitation – A Potential Alternate Process in Dairy Industry

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Hydrodynamic cavitation (HC) is a process in which high energy is released in a flowing liquid upon bubble implosion due to decrease and subsequent increase in local pressure. It is characterized by high effectiveness, good scalability, and synergistic effect with other physical and chemical methods, has emerged as the promising technology for industrial-scale applications, while cavitation has been a serious problem in a hydraulic system, its energy can be used for various physical and chemical processes. The phenomenon of hydrodynamic cavitation involves the formation, growth, and subsequent collapse of bubbles when a given liquid experienced are duction of pressure below its vapor pressure. The presence of cavitation limits the performance and the safe operation of many machineries and pumps. However, innovation in the design of the hydrodynamic cavitation devices has offered promising applications in the dairy and food industry. Upon collapse of the cavities, the fluid experiences significant mechanical effects (shear and turbulence) as well as instantaneously elevation of the fluid temperature. All these effects can be put to work for mixing, dispersion, particle size reduction, disinfection, and emulsification. The advances in HC applications, and development of hydrodynamic cavitation reactors, which is supposed to contribute to the fundamental understanding of this novel technology. This study includes a general overview of hydrodynamic cavitation-based processing technologies and discussion regarding the process effectiveness and its application in dairy and food industry.

Keywords: Hydrodynamic cavitation, reactors, dairy industry etc.

PS 1.2 Hurdle Technology in Dairy and Food Industry

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This is era of innovation; technology and technique in the field of food industry where day by day new products are develop with using new and innovative techniques such as hurdle techniques. Hurdle technology is one the best technology using in recent year with the aim of providing natural, Safe, stable, economic, healthy products free from microbial spoilage. This technique focused on sensory analysis as well as physiochemical and microbial analysis of food products. The main aim of this technique to secure microbial safety, organoleptic stability and enhance the shelf life of food products with minimum uses of chemical preservatives and maintain the natural, nutritive value of food products. Several hurdles such as temperatures (high, low), water activity, preservatives, acidity, microorganism are using as hurdles for preservation of meat, fish. Milk and vegetables. Recent hurdles technology that are applied in various food products are ultra-high pressure, edible coating, ethanol coating, modified atmospheric packaging, milliard reaction products etc. Hurdle technology using different hurdle such as antimicrobial additives, thermal treatments, ultraviolet or pulsed light with the help of non-thermal technologies as they combine to eliminate the food hazards and provide better quality food products with natural and tasty flavor.

Keywords: Hurdle technology, preservation, hazards, thermal processing, quality, stability etc.

PS 1.3 Compatibility Assessment of *Kluyveromyces lactis* with Probiotic Lactic Bacilli and Antimicrobial Potential of Various Probiotic Strains for Manufacturing of *Manouri* Cheese

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The study was conducted with an objective to assess the compatibility between probiotic yeast *Kluyveromyces lactis* and potential probiotic lactobacilli strains, namely *Lacticaseibacillusparacasei* subsp. *paracasei*, *Lactobacillus acidophilus*, *Lacticaseibacillus rhamnosus*, *Lactiplantibacillus plantarum* subsp. *plantarum*, and *Lactobacillus helveticus*. The antibacterial activity of *Kluyveromyces lactis* and various probiotic Lactobacillus species was investigated to select the most suitable probiotic culture for their further uses in product development. The spot assay on MRS agar confirmed equal growth intensity and absence of incompatibility between *K. lactis* and probiotic Lactobacilli spp. Their cultures mutually enhanced each other's growth. Most probiotic lactobacilli strains exhibited significant antibacterial activity against tested pathogens, while *K. lactis* showed no antibacterial activity. *L. casei*, *L. rhamnosus*, and *L. plantarum* displayed the highest antibacterial activity.

Keywords: Manouri Cheese, *Lactobacillus acidophilus*, probiotic, Antimicrobial Potential etc.

PS 1.4 Development of Xanthan Gum Incorporated Honey Filling: Quality Attributes, Baking Stability, and Rheological Behaviour

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Nowadays, filling-incorporated bakery products have been highly demanded in global market due to taste, texture and nutritional value. Xanthan gum was added to honey to develop rheologically improved and heat-stable honey filling without compromising quality attributes of honey**.** The present work emphasizes the development of xanthan gum incorporated honey filling as a bakery filling ingredient. The honey filling was prepared using xanthan at different concentrations (0.5-2.0 % (w/w). The apparent viscosity of raw honey was 6.1 Pas indicating Newtonian behavior. However, increasing the concentration of XG from 0.5 to 2.0 (w/w) increased the viscosity from 18.6 to 3060 Pas, showing shear thickening behaviour. Herschel Bulkley model was found to be the best suitable model at higher concentration (>1.0%). XG-based honey filling had a more viscous component (G") than the elastic component (G') up to 1% (w/w) concentration. After that, the trend was reversed (G'>G") and converted from liquid to non-flow. With increasing the concentration of XG (0.5-2%), firmness and adhesiveness were increased from 2.28 to 27.57g and from 2.64 to 146.16 gms, respectively. The highest baking stability index was found to be 95.30 % (at 2% concentration of XG) at 180°C. The slight decrease in total phenolic components (7.04%-14.74%) and antioxidant activity (7.32-9.34%) showed the quality attributes stability of the honey filling.

Keywords: Heat stable honey, antioxidant property, xanthan gum et

PS 1.5 Effect of Radial Flow Type Vapour Ejection System on performance parameters of Scraped Surface Heat Exchanger

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Scraped Surface Heat Exchanger (SSHE) are used for various purposes in the industry and also have significant role in the manufacture of the Traditional Indian Dairy Products. Hence, industries are focuses on the efficient working of the equipment's with effectiveness. Efforts were made to improvise the thermal performance of SSHE by means of Radial Flow Type Vapour Ejection System (RTVES). The present investigation was with an intention to intensify the process of heat transfer. The air flow rate of RTVES and steam pressure varied in different combinations while speed of scrapper, feed rate and initial total solids of milk kept constant for assessment of performance parameters. The effect of RTVES was studied on influencing parameters of thermal performance. The significant increase in rate of evaporation, overall heat transfer co-efficient, steam economy was found with increase in air flow rate and steam pressure. Whereas, steam consumption was significantly reduced compared to SSHE without ejection system. The vapour removal mechanism prevents accumulation and condensation of vapour inside the SSHE shell which reduces the partial vapour pressure which exerts when evaporation of water in SSHE. Implication of vapour exhaust system on SSHE considerably improved thermal performance with economy in energy and processing cost.

Keywords: Scraped Surface Heat Exchanger, Overall Heat Transfer Co-efficient etc.

PS 1.6 Triply Metals: A novel approach for Dairy Processing Equipment Design

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India is the world's largest producer of milk, accounting for around 24% of the global milk production. Dairy processing equipment plays a crucial role in the production of various dairy products, such as milk, cheese, butter, yogurt, and ice cream. The design and construction of dairy processing equipment require materials that possess superior mechanical properties, corrosion resistance, and hygienic characteristics. Triply metals, composed of three layers with a stainless-steel core sandwiched between two layers of copper or aluminium, have emerged as a promising choice for such applications. Triply metals offer numerous advantages for the design and fabrication of dairy processing equipment. Their enhanced heat transfer, corrosion resistance, uniform heat distribution, mechanical strength, and ease of maintenance make them an attractive option for the industry. The long-term benefits of triply metals in terms of equipment performance, longevity, and compliance with hygiene standards underscores the potential of triply metals as a viable solution for enhancing efficiency and hygiene in dairy and food processing industries. Advancements in triply metal technology, expanding their application and impact on the dairy and food processing industry.

Keywords: Triply metals, dairy processing equipment, cost-effectiveness etc.

PS 1.7 Kinetic Modelling of Ghee Degradation under Sub-baric and Conventional Frying of *Gulabjamun*

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The effect of sub-baric frying on the thermal stability of frying medium was evaluated by comparing physico-chemical indices of ghee subjected to cyclic frying under sub-baric and conventional frying conditions. Frying experiments were conducted using ghee across 3 shifts spaced 8 h apart, each shift comprised of 5 frying cycles, wherein *Gulabjamun* was fried in ghee and a sample of 50 ml was drawn from the lot after the frying medium cooled to room temperature. The time between two consecutive frying cycles within a shift was maintained at 1 h. The process conditions identified for the study were sub-baric frying at 120, 135 and 150 ^{o}C for 5 min at 400 mmHg and conventional frying at 145^{o}C for 5- and 10-min. Kinetics of the change in peroxide value, TBA content, viscosity and colour indices were modelled using zero, first, fractional first order and Weibullian models. The exponential models were found to describe the kinetics of the physico-chemical changes better than zero order model. The colour indices, Yellowness Index and Chroma were better described using zero order model. Temperature dependence of the rate constant during sub-baric frying was adequately modelled using Arrhenius equation for the shift 1 and 2. The temperature dependence of the rate constant was further elucidated using the Q15 values. Modelling of the kinetics of changes in the Ghee samples subjected to sub-baric frying process helped gain an insight into the rates of the changes across the 3 shifts evaluated and quantified the rate constants.

Keywords: Degradation, sub-baric, conventional, peroxide value, modelling etc.

PS 2.1 Application of Renewable Energy Source

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At present price of fossil fuels are increases at a very fast rate which affect food industry directly or indirectly. Due to this price of food product increases day by day. So, there is a need of renewable energy source which is not only beneficial for industry but also protect our ecosystem from unwanted environmental factors. Major sources of renewable energy are sun (solar energy), wind (wind power), rivers (hydroelectric power), hot springs (geothermal energy), tides (tidal power), and biomass (bio fuels). In these sources the best energy sources is solar energy which at present Increases at very fast rate in rural areas due to free spaces of land and maximum light receives from sun at critical day hours that is (10 am-4pm). In urban areas due to increases in price of electricity most of the people setup solar system in home, factory, shops, and petrol pump etc according to their need of consumption either 1kw or more or less it depends upon the capacity of solar panel. Government of India also encourages and provide subsidy to setup of solar system either for industry or home purposes as they want to connect the whole world in one grid system that is solar grid system. If this system setup in whole world, then we take energy where the sun is and send the energy where sun is not. Means transportation of energy in form of electricity take place from efficient area to deficient area.

Keywords: Fossil fuels, solar energy, bio fuels, geothermal energy etc.

PS 2.2 Harnessing Solar Energy: Advancing Sustainability in the Dairy Industry

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The dairy industry is increasingly turning to solar energy as a sustainable and environmentally friendly solution. Solar power plays a pivotal role in reducing carbon emissions, enhancing energy efficiency, and fostering sustainability in dairy operations. With the global demand for dairy products, a shift towards sustainable energy sources is imperative. Solar energy, particularly through photovoltaic (PV) systems, allows dairy farms and processing facilities to generate clean electricity, powering essential operations like milk cooling, lighting, and equipment. This reduces reliance on conventional energy sources. Solar thermal technologies further advance solar energy integration in dairy processes. By using solar thermal systems to heat water for cleaning, sterilization, and pasteurization, the industry can reduce its dependence on fossil fuel-based heating systems. This transition not only cuts energy costs but also significantly minimizes greenhouse gas emissions, supporting sustainable practices. Solar energy also proven invaluable for off-grid dairy operations in remote areas. Solar-powered microgrids provide electricity to dairy facilities lacking access to conventional power grids, fostering economic development and livelihoods in regions with limited electricity access. By embracing solar energy, the dairy industry can mitigate carbon emissions, enhance energy efficiency, and move toward a greener and more sustainable future.

Keywords: Solar energy, fossil fuel, microgrids, sustainability etc.

PS 2.3 Therminol 55-based Nanofluids for Efficient Milk Heating

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Energy efficiency is the prime goal of the modern industrial world. Using synthetic oil-based nanofluids (NFs) instead of water for heat transfer applications is an excellent energy-saving alternative. Adding nanoparticles (NPs) reduces the specific heat of synthetic oils and improves their thermal conductivity. Zinc oxide and alumina-doped zinc oxide NPs are synthesized using cow urine to decrease dairy waste and for sustainable dairying. Therminol 55 is a synthetic oil with an operating temperature up to 290°C.Therminol 55-based ZnO and AZONFs were prepared at 0.1, 0.2 and 0.3 vol.% for milk heating. AZO NFs showed higher thermal conductivity than ZnO NPs, which increased with the temperature and concentration of NPs. The AZO NFs showed a maximum increase of 30, 19.98 and 22.63% for convective heat transfer coefficient, overall heat transfer and energy efficiency, respectively, when compared with Therminol 55. Additionally, the maximum reduction in energy consumption after utilising ZnO and AZO NFs was 3.26 and 5.40%, respectively. It is concluded from the present study that AZO NFs possess better heat transfer properties, resulting in a reduction in energy consumption than ZnO NFs and Therminol 55 for heating milk in a tubular heat exchanger.

Keywords: nanofluids, cow urine, synthetic oils, reduced energy consumption etc.

PS 2.4 Heating Pattern Studies on a Thermic Fluid-based Prototype System

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Thermal performance evaluation studies were conducted with water on thermic fluid-based prototype system with electric heating. Therminol-55is a clear yellow synthetic hydrocarbon mixture used for heat transfer in liquid phase for indirect process heating. It is used as heat transfer fluid in low pressure or non-pressure systems at moderate temperatures. The system's thermal behaviour (total heat load, heating rate, heat loss and thermal efficiency) was evaluated at two different initial thermic fluid temperatures, employing 1 kW and 2 kW heating elements. Fora 2 kW system, up to 150°C thermic fluid temperature was attained, resulting in elevated total heat load compared to 1 kW system. Higher power input load (2 kW system) resulted into higher total heat load (1.14 kW) as compared to that of 1 kW system (0.62 kW). Higher heat loss observed in a 2-kW system (0.86 kW) than 1 kW system (0.37 kW). The 2-kW system achieved desired temperature more rapidly when combined with a higher initial thermic fluid temperature resulting in a high heating rate (1.38 K/min) as compared to 1 kW system (0.73 K/min). However, 1 kW heating element exhibits greater thermal efficiency (62.43%) due to its lower heat dissipation.

Keywords: Heating pattern, Therminol-55, water, heat load, heating rate, thermal efficiency etc

PS 2.5 Magnetic Induction Heating of Milk: Impact on Quality

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Magnetic Induction Heating (MIH) is an electromagnetic non-contact heating method which is being efficiently utilized in food processing nowadays. Heating plays a critical role in the dairy and food industry, particularly in ensuring the safety of milk for consumption and extending its shelf life. The possibility to heat milk and other dairy products using MIH is yet to be explored. The study aimed to assess the quality of milk heated using a laboratory-scale batch-type MIH unit. The study employed seven adjustable induction powers, and milk was heated from 10 to 90°C. The results revealed that heating time gradually decreased from 187 to 114 s as the induction power increased from 500 to 2000 W. The levels of fat, solid not fat (SNF), and protein were statistically similar before (3.96% fat, 8.46% SNF, and 3.34% protein) and after heating (3.93-3.98% fat, 8.37-8.41% SNF and 3.34-3.40% protein). However, microbial parameters exhibited significant variability ($p<0.05$) depending on the applied induction power. Since MIH can save energy by eliminating the need for steam and its associated auxiliary components, this technology has emerged as a potential alternative to heat milk with shorter time and minimum quality degradation.

Keywords: Induction Heating, quality, water, consumption, electromagnetic etc.

PS 2.6 Phase Change Slurries as Active Cooling System

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Phase change slurries (PCSs) are new highly efficient heat transfer fluids that meet the demand of efficient cooling system. It also addresses the problem of enormous strain on electricity consumption and indirectly reduces the greenhouse gas emission. PCSs are actually a binary system, which consists of a carrier fluid, mostly water as the continuous phase, and a phase change material (PCM) as the dispersed phase. These fluids can be used as both heat transfer fluid as well as cold storage media. One of the major benefits of PCSs compared to pure phase change materials is their fluidity and high heat storage capacity. However, these PCSs have certain problems that hinder their commercialization like Supercooling, poor heat-transfer and leakage which can be solved by encapsulation, by the addition of highly conductive materials and by macro, micro, or nanoencapsulation respectively. Hence, the use of encapsulated PCM slurries is gaining interest which are capable to enhance the thermal capacity of secondary fluid systems. Four main categories of encapsulated PCMs have been identified: shape-stabilized PCM, PCM emulsion, clathrate hydrate PCM slurry, and nano/microencapsulated PCMs. Phase change slurries have found great potential in cooling, cold energy storage, and cold energy transportation systems due their elevated phase change temperatures and are used in aerospace applications, cold storage and air-conditioning system.

Keywords: Phase change slurries, Supercooling, cold energy storage, microencapsulated etc.

PS 2.7 Cost-Effective Solar Fermentation Unit: A Green Approach to Dairy Processing

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A low-cost batch fermentation unit designed for *dahi*, and yogurt production utilizes renewable solar energy as its primary heating source. This innovative system combines an electric heater and phase change material (PCM)-based heating with a solar flat plate collector (FPC), an electric heater and blower assembly, a fermentation cabinet with trays, and an evaporative cooling system. During sunny hours, the FPC collects solar heat, which is then blown into the fermentation cabinet, maintaining the desired temperature. In the absence of sunlight, the hybrid heating system takes over. Computational fluid dynamics (CFD) simulations and experimental data validate temperature distribution and airflow inside the fermentation cabinet. The system effectively pre-cooled cups, achieving a significant temperature drop of 16 ℃ in summer and cooling to 5.5 ℃ in peak winter. Comparative analysis showed no significant differences in product quality compared to conventional methods. Importantly, the solar system exhibited significantly lower energy consumption, making it a cost-effective and eco-friendly alternative to conventional electrical units. In conclusion, this solar-powered fermentation unit proves to be an efficient, cost-effective, and environmentally friendly solution for *dahi* and yogurt production, offering excellent product quality while reducing energy consumption compared to traditional methods.

Keywords: Computational fluid dynamics, hybrid heating, phase change material etc.

PS 2.8 Modelling of Mass Transfer Characteristics with Eddy Diffusion in a Horizontal Thin Film Scraped Surface Heat Exchangers under Vacuum

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It is necessary to minimize the cost of energy consumption in production of quality products in continuous system of thin film scraped surface heat exchangers (TFSSHEs) under vacuum. In this study, the double rotary vacuum seal and rotor assembly with staggered blades were used in TFSSHE to concentrate buffalo milk with sugar as a working liquid (SCM WL) under vacuum. The flow rate varied from 50 to 200 liter/hrs.; rotor speed varied from 2.33 to 4.00 rps and steam pressure varied from 0.25 to 1.5 kgf/cm^2 gauge. The velocity of eddy diffusion due to physical mixing through rotation of scraper blades in TFSSHEs and concentration gradient was determined in terms of liquid water diffusivity (D_v) using Fortran software to optimize the process variables. The partial regression coefficient of X_{av} and ΔT were significant at $P \leq 0.01$ having inverse effect on D_v and regression coefficient, R^2 of 0.94. ANOVA with interaction was performed to determine the effects of mass flow rates, steam condensing temperature and linear speed of rotor on mass diffusivity of water (D_v) in concentrating SCM WL. Least square means of D_v was in increasing trend with mass flow rate ($P \leq 0.01$) and in decreasing trend ($P \leq 0.01$) with Steam condensing temperature and total solids of working liquid. Modelling of Sherwood number (N_{sh}) as a function of Re_f (Flow Reynolds number), Rotational Reynolds number (Re_r), Schemidt number (Sc) and $\Delta T/T_s$ was correlated in the Cobb-Douglas model with R^2 as 0.91which were significant at $P \leq 0.01$. The increase in Re_f and Sc decreased the N_{sh} ($P \leq 0.01$), however the effect of rotational Reynolds number (Re_r) and $\Delta T/T_s$ was found to increase the mass transfer rates ($P \leq 0.01$). The Re_f and Sc were inversely affecting the correction factor i.e. $(N_{sh})_{observed}$ / $(N_{sh})_{penetration\ theory}$ which were significant at $P \leq 0.01$ with correlation coefficient of 0.95.

PS 2.9 Nanofluid: An Effective Heat Transfer Fluid for the Dairy and Food Industry

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Heat exchangers find widespread utility in diverse sectors to facilitate energy conversion, preservation, and efficiency. Enhancing heat exchanger performance is a major hurdle, requiring improvements in energy efficiency and reduced heat transfer time. Leveraging nano fluids represents a top-tier choice for augmenting heat transfer rates, owing to their exceptional thermal conductivity, while simultaneously addressing the economic concerns linked to heat exchangers. A "nanofluid" is a heat transfer fluid with suspended nanoparticles sized between 1-100 nm, dispersed in the base fluid. Nanofluids are advanced fluids comprising non-dissolving conventional fluids with dispersed nano-sized particles. Nanofluid classification is rooted in the choice of nanoparticles used. There are four main groups i.e., metal-based, carbon-based, metal oxide-based, and mixed/hybrid metal-based nanofluids. Commonly, two techniques are used for making nanofluids such as single-step (small-scale and suitable for metallic nanoparticles) and two-step (economical and for mass production) methods, both yielding stable nanofluids with desirable properties. It is widely recognized that CNT nanoparticles, including SW, DW, and MW variants, exhibit superior thermal properties compared to metallic or metal oxide nanoparticles. The aim of using nanofluids in PHE is to achieve the highest heat transfer rates by enhancing the inadequate thermo-physical properties of the base fluid, ideally with a low concentration of uniformly dispersed nanoparticles (preferably in the range of 10 to 50 nm) within the conventional fluid. Implementing this nanofluid technology as heat transferring medium in dairy and food industry can result in improved heating or cooling processes, leading to energy savings, higher thermal efficiency, and reduced processing times.

Keywords: Heat exchangers, nanoparticles, heat transfer rates, efficiency etc.

PS 3.1 Enhancing Efficiency and Quality Control in the Dairy and Food Industry: The Role of Machine Learning

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Machine learning, a subset of artificial intelligence, has found extensive applications in the dairy and food industry, offering numerous benefits such as process efficiency, quality control, and product innovation. Through the analysis of large datasets, machine learning algorithms can identify patterns, make predictions, and offer insights to enhance decision-making. Quality control in the industry is significantly improved through machine learning, which can detect contaminants, spoilage, and defects by analyzing extensive datasets. It enables timely corrective actions and ensures compliance with quality standards. Additionally, machine learning enhances food safety and traceability by analyzing sensor data and historical records to predict and prevent foodborne illnesses. It also aids in efficient product traceability throughout the supply chain, ensuring compliance with regulations and effective recall management. Machine learning's impact extends to product development and customization. By analyzing consumer preferences, market trends, and sensory data, algorithms identify opportunities for new product formulations and personalized recommendations. This customization enhances customer satisfaction and fosters innovation. In conclusion, machine learning has become integral to the dairy and food industry, offering applications in quality control, food safety, traceability, and product development. Its implementation enhances efficiency, ensures product safety, meets consumer demands, and drives sustainable growth.

Keywords: Quality control, machine learning, traceability, sustainable growth etc.

PS 3.2 Python Based Simulation Tool for Prediction of Colour Properties of Butter

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Colour, visual appearance, and texture are all factors that influence customer purchasing decisions. Computer vision is one option for an automated, non-destructive, and cost-effective method to meet these needs. In this study, various established colour gradations were utilized to analyses the colour characteristics of butter on the basis of temperature. Lab colour scale, Whiteness Index, and Yellowness Index, out of 10 various scales and colour indices, produced the most significant findings for characterising the butter sample. Different camera orientations and geometries are utilised to get the most advantageous posture for picture capture. Software called Scilab and Python were used to analyse images of butter. The majority of color measurement equipment and computer vision systems are devoid of temperature control mechanisms. It is necessary for dairy products like butter that have characteristics that change depending on the temperature.

Keywords: Colour, Machine vision, Colour Index, Colour Scale, Butter, thermal integration etc.

PS 3.3 Machine Vision Technology in Food Processing Industry: Principles and Applications

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Machine vision technology has emerged as a game-changer in the food processing industry, fundamentally altering the landscape of quality control, automation, and operational efficiency. This abstract provides a concise overview of the principles and multifaceted applications of machine vision within the realm of food processing. By emulating human visual perception and decision-making processes, machine vision harnesses computer-based systems to scrutinize and analyze food products swiftly and with extraordinary precision. The core principles that underpin machine vision systems encompass image acquisition, preprocessing, feature extraction, and algorithm-driven decision-making. In the food processing sector, machine vision finds diverse applications across various stages of production and packaging. Noteworthy among these applications are quality control, where machine vision systems meticulously inspect food items for defects, contamination, or irregularities, thereby ensuring only superior products reach consumers and minimizing waste. Moreover, machine vision facilitates the automated sorting and grading of fruits and vegetables based on attributes such as size, color, and shape. It also plays a pivotal role in assessing packaging integrity, verifying labels, and ensuring compliance with regulatory standards. Beyond quality control, machine vision contributes to traceability efforts, detects foreign objects in food products.

Keywords: Machine vision technology, image acquisition, minimizing waste etc.

PS 3.4 Robotics: Future of Food and Dairy Industry

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Robotics and artificial intelligence (AI) are now widely used in the dairy and food industries. Robots are adaptable electrical machines that can be set up to perform a wide range of jobs. They are beneficial because they increase output, accuracy, quality, and flexibility in the sector. Robotics' potential has significantly expanded thanks to technological innovation, which has made it possible for it to replace human employees. Previously, robots were only used for packaging and palletizing but are now used in almost all unit operations, from farming to manufacturing, including automatic milking, harvesting, sorting and grading, cooking, pick-and-place, cartooning, labeling, packaging, meat processing, sensory analysis, and even delivery. AI-based innovations have also helped with data processing, monitoring, and human-machine cooperation. Overall, though, it is clear that the food industry is undergoing a significant shift to meet the needs of an expanding population. In order to create new growth paths, the primary objective of today's industrial sector is to concentrate on competitiveness through the use of ICT technology. The expanding usage of robotics in the dairy and food processing industries is highlighted in this paper.

PS 3.5 Different Types of Artificial Intelligence (AI) Tools Used in Dairy Industry

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Artificial Intelligence (AI) known as the simulation of human intelligence in a machine that is programmed to think like human and mimic their actions. The use of AI can perhaps bring a revolution in the dairy industry starting from the dairy farms to the consumer's plate. With use of AI technology in the dairy industry, most of the work involved in the dairy farm practices as well as in the processing industry for preparation of dairy products can be automated which may eventually save time and money. There are a number of AI applications usable in the dairy industry that includes use of robots, drones, sensor, automatic milking 3D printing, virtual reality and artificial neural networks (ANN). The introduction of newer digital technologies such as robots, drones, sensors, 3D printing, virtual reality and artificial neural networks will greatly aid in increasing the efficiencies and help the dairy industry to rise and meet the demands of the global population. With the application of AI technology in the dairy industry, it will revolutionize the whole dairy sector in the days to come. Dairy farmers can use predictive analytics to react to changing conditions, mitigate risks, and increase productivity.

Keywords: 3D printing, artificial neural networks, virtual reality, robots etc.

PS 3.6 Revolutionizing Dairy Production: Harnessing the Power of Robotics in Dairy Processing

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Integrating robotics technology in dairy processing has ushered in a new era of efficiency and productivity. This abstract explores the transformative impact of robotics on various stages of dairy production, from milking to packaging. Robotics systems, equipped with sophisticated sensors and Artificial Intelligence (AI) algorithms, ensure precise and hygienic milk collection, reducing labor-intensive tasks and minimizing human errors. In cheese production, robotic arms handle delicate processes such as curd cutting and molding with unparalleled precision, enhancing the consistency and quality of the final product. Implementing robotics optimizes production efficiency and ensures adherence to stringent hygiene standards, which is vital in the dairy industry. Robotic automation also addresses labour shortages, a significant concern in many dairy processing facilities. By taking on monotonous and strenuous activities, robots allow skilled workers to focus on more complex aspects of production, fostering a harmonious synergy between human expertise and robotic precision. In conclusion, the use of robotics in dairy processing not only enhances efficiency and product quality but also addresses crucial challenges faced by the industry. As technology advances, the integration of robotics is poised to revolutionize dairy processing; creating a future where precision, consistency, and innovation are the hallmarks of the industry.

Keywords: Robotics, Artificial Intelligence, Dairy, Automation, hygienic milk collection etc.

PS 3.7 Internet of Things (IoT): A Smart Solution for Quality and Efficiency in Dairy Product Manufacturing

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Adopting the Internet of Things (IoT) in dairy is a pivotal paradigm shift, bringing in an entirely novel age of sustainability, quality assurance, and efficiency. This abstract examines the various ways of IoT application in the dairy industry, encompassing various stages of production, from farm to processing and distribution. IoT-enabled sensors and devices empower dairy farmers to monitor and manage their herds precisely. Real-time data on animal health, nutrition, and behavior assist in optimizing milk production and quality. Moreover, IoT-equipped farm machinery enhances feeding, milking, and waste management efficiency. In dairy processing, IoT technology ensures seamless automation and quality control. Innovative processing units are equipped with sensors that monitor every aspect of production. This real-time data stream allows quick adjustments and proactive maintenance, reducing downtime and product waste. The IoT's impact extends to the supply chain, enabling end-to-end visibility and traceability. Smart logistics and distribution systems optimize routing, temperature control, and inventory management, ensuring dairy products reach consumers optimally and minimizing food wastage. In conclusion, the IoT's incorporation in dairy product manufacturing signifies a transformative leap toward precision, efficiency, and sustainability. By harnessing the power of interconnected devices and data analytics, the dairy industry can meet evolving consumer demands while advancing its commitment to quality and environmental responsibility.

Keywords: Internet of Things (IoT), smart logistics, maintenance, efficiency etc.

PS 3.8 Non-destructive Techniques: Fortune for Quality Analysis of Milk and Milk Products

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The dairy industry is vital to global food production; thus, milk and milk products must be of high quality for public health and economic sustainability. Traditional quality control methods often involve destructive testing, leading to waste and costs. The non-destructive analysis techniques are indispensable in the dairy and food industry, safeguarding product quality without compromising composition. Non-destructive testing (NDT) is an overarching term that encompasses a gamut of methods for evaluating materials and components, allowing their examination without altering their functionality. NDT techniques such as Near-Infrared Spectroscopy, Ultrasound Imaging, X-ray Imaging, Magnetic Resonance Imaging, Hyperspectral Imaging, Raman Spectroscopy, Terahertz Imaging, Electromagnetic sensors, Acoustic Resonance Spectroscopy, and Computer Vision Techniques are invaluable, rapid and reliable for assessing critical quality attributes in dairy and food industry, including freshness, composition, structural integrity, moisture content, composition, density, texture, microbial contamination, ripeness, maturity, foreign object detection, colour analysis, and defect detection. While NDT offers immense potential for enhancing quality control and analysis in the dairy and food industry, its full-scale adoption faces challenges like cost, complexity, and integration into existing processes. Standardization, regulatory compliance, and robust data management are essential for building trust in these non-destructive methods. Nevertheless, as technology advances and these obstacles are addressed, NDT is poised to revolutionize quality assurance practices, contributing to safer and more efficient production processes in the food and dairy sectors.

Keywords: X-ray Imaging, Electromagnetic sensors, Non-destructive testing, etc.

PS 4.1 Novel Bio-based Nutritional and Functional Mango Juice Enriched with *Lactobacillus acidophilus*

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The study aimed to enhance and upgrade existing technology on a pilot scale, focusing on the microbiological, biochemical, and sensory evaluation of probiotic mango juice produced in the pilot plant. *Lactobacillus acidophilus* (MTCC 10307) probiotic culture was incorporated into mango juice at an initial concentration of 10^8 CFU/ml. Over a six-week period, we monitored probiotic viability, titrable acidity, pH, total sugars, TSS (Total Soluble Solids), reducing and non-reducing sugars, antioxidant activity, Vitamin C content, lactic acid levels, and microbial contaminants in the newly developed probiotic juice on a weekly basis. Probiotic viability remained consistently above 8 log CFU/ml for up to 28 days in the pilot plant-produced probiotic mango juice. Total plate count, yeast and mold count, and coliform count remained within acceptable limits during the first four weeks of storage at 4°C. The average sensory score for the acceptability of the developed probiotic mango juice was 8.03. Technological viability assessment indicated a production cost of Rs 135/- for 1 liter of probiotic mango juice. Considering the significant probiotic viability (10^8 CFU/ml) up to 4 weeks of storage, this fruit-based probiotic beverage holds promise as an appealing choice for consumers of various age groups. The developed method for preparing probiotic mango juice is economically feasible and has the potential for industrial exploitation.

Keywords: *Lactobacillus acidophilus*, Probiotic viability, Technological viability etc.

PS 4.2 Preparation of Functional Dairy Based Beverage with Addition of Natural Sweeteners

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The aim of this study is to propose a research approach for optimization of technology for preparation of dairy-based functional beverage with the addition of natural sweeteners like brown sugar, jaggery, date syrup and sugar along with addition of resveratrol emulsion due to their potential health benefits. To increase the functionality, first milk beverage was prepared utilizing different types of natural sweeteners and resveratrol nanoemulsion. The replacement of sugar with natural sweeteners not only enhance the taste but also promotes the consumer's health. The natural sweeteners were used ranging between 6-12% based on their sweetening effect and different levels of resveratrol nano emulsion were used for the optimized product. The main findings of the research were that how the natural sweeteners affect the properties of milk. The antioxidant activity was 40.12, 48.9, 47.32 and 36.18% for the milk beverage with brown sugar, jaggery, date syrup and sugar respectively. Consumer study was conducted to see the market potential of the product. With the rising concern over excessive sugar intake, the use of natural sweeteners can contribute to healthier dairy based options. The integration of natural sweeteners into dairy based beverage represents a promising avenue for enhancing flavor, nutrition, and overall product appeal.

Keywords: Functional beverage, nanoemulsion, natural sweeteners, resveratrol etc.

PS 4.3 Research on the Sensory Quality and Cost Structure of Curd Prepared by using Different Utensils

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In the family of fermented milk curd is one of the most important products. Research work on studies on quality of curd prepared by using different utensils was undertaken with a view to find out response of different container viz. earthen container, stainless steel, aluminum, plastic and China clay container on quality of curd preparation. The curd was prepared by using earthen (T_1), stainless steel (T_2), aluminum (T_3), plastic (T_4) and China clay (T_5) utensils with five treatments and four replications. The data were statistically analyzed by completely randomized design (CRD). Samples was evaluated for sensory evaluation by using 9-point hedonic scale. It was observed from the present study that, he curd prepared in earthen container (T_1) had highest score for flavour (8.83 out of 9), body and texture (8.67 out of 9), colour and appearance (8.70 out of 9) and overall acceptability (8.78 out of 9) by 9 point hedonic scale and ranked as the most acceptable treatment .Good quality curd can be prepared by using earthen container had pleasant flavour, smooth body and texture and light yellow colour and was found superior over the rest of the treatments. The cost of curd prepared in earthen container (T_1) was Rs. 60.87 per kg which was less when compared with treatment T_2, T_3, T_4, T_5. Hence, it is concluded that good quality of curd was made in earthen container (T_1).

Keywords: Milk, curd, Sensory attributes, cost structure, container etc.

PS 4.4 Recent Advances for Manufacturing Instant Dairy Based Dry-mix

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In the recent years, dairy based instant dry mixes are becoming more and more popular among the consumers mainly due to the convenience they offer during preparation of the products. The current traditional methods of product preparation are of labour intensive and time consuming and more suitable for small-scale production. The chemical and rheological properties of traditional products are never uniform due to variations in the chemical composition of milk resulting in variation in product quality. In recent year, number of techniques has been developed for manufacturing convenience instant mixes of several dairy products and those techniques are dry blending, tray drying, vacuum tray drying, roller & spray drying, osmotic dehydration and crystallization drying process. Several dry mixes of indigenous dairy desserts available in the market are ready-to eat, while some mixes require preparation steps. Recently some novel techniques such as dry-crystallization and spray coating has been adopted for manufacturing various dairy based dry mix and now they are becoming more and more popular throughout the world. There is huge scope for the engineers in the area of food science and technology for development of equipment's and mechanized process for manufacturing that dairy based instant dry mixes.

Keywords: Instant mixes, dry-crystallization, spray coating, ready-to eat etc.

PS 4.5 Natural Additives in Colored Wheat Based Functional Food Products: Opportunities for Enhanced Nutritional and Functional Properties

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Nowadays, there is a growing consumer demand for the preferences of higher functional value products that can meet the nutritional requirements of functional compounds. Wheat is one of the most important agricultural crops in the world and ranked second in terms of production and consumption in India. To improve the functional and nutritional properties of any developed products, colored wheat has become a very attractive option. Moreover, the use of Colored wheat varieties have the potential to combat problems like malnutrition. Thus, the present research work was designed to investigate a comparative evaluation between the colored wheat (black and purple wheat) and regular wheat varieties on the basis of their proximate analysis, phytochemical analysis, physical and functional properties. Results indicated that the colored wheat varieties have high protein content in comparison to regular wheat although its gluten content is low. Compared to colored varieties, purple wheat has the highest fibre content (7.70±0.21). Among all the wheat varieties, black wheat is a good source of anthocyanin (60.3±0.36mg/kg), phenolic content (112.5±0.33mg GAE/100g), flavonoid content (26.50±0.11mg QE/100g) and antioxidant activity (74.41±0.69%). The incorporation of remarkable attributes of colored wheat can be used more effectively to produce high-value items including bread, biscuits, pasta, noodles, bars, and crackers, *gulabjamun, jalebi, ghevar*, wheat porridge. In addition, the incorporation of colored wheat in various bakery and dairy products enhances the nutritional and functional health benefits of the product. The addition of anthocyanin-rich wheat instead of regular wheat in bakery and dairy products will prevent lipid oxidation, as it is an effective antioxidant property.

Keywords: Colored wheat, anthocyanin content, gluten, phytochemicals properties etc.

PS 4.6 Optimization of Different Process Variables on Quality Attributes for the Development of Creamed oney

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The use of natural honey as a food has been retarded since ancient times. Because it tends to become gritty in texture over time due to the formation of larger crystals having various degree of coarseness. If the tendency of crystallization reduces by heating, the honey in the form of liquid is of a consistency difficult to spread on the food. To overcome this problem, the primary objective of the present investigation is to produce creamed honey from blending the mixture of crystallized honey and raw honey in various proportions. Three different variables such as crystallized honey concentrations (10, 15 and 20%), blending speed (96, 192, 288 rpm), and mixing time (10, 20, and 30 min) were selected to produce creamed honey. In Design Expert software, the response surface methodology (RSM) was used to generate an experimental design (Box Behnken Design) with taken the response variable of overrun. The surface plots revealed different interactions, and their implications on the relative responses to the optimization process were investigated. The optimal results were found for preparing creamed honey having crystallized honey concentration of 15%, blending speed of 288 rpm, and the mixing time of 30 min. Additionally, the raw honey and creamed honey were tested to analyze their physiochemical, rheological, antioxidant properties. Rheological results indicated the flow behavioral pattern of non-Newtonian fluid having the viscosity ranged from 11.9 Pa.s to 74 Pa.s. The antioxidant properties (Total phenolic content: 47.86 mg GAE/100 g; total flavonoid content: 27.48 mg QE/ 100 g; antioxidant activity: 47.65%) of creamed honey having overrun 8.2% (optimized product) was found better as compared to raw honey and other combinations of creamed honey. The study thus reflects that this optimized creamed honey may find the application to use it as a spread for bread and cracker, dip for fruits and veggies, filling for cakes and pastries and added to teas and hot beverages like hot chocolate, coffees.

Keywords: Crystallization, cream honey, RSM, overrun, antioxidant properties etc.

PS 4.7 Characterization of Low-Fat P*aneer* Spread Incorporated with Processed Mint

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The study was carried out to develop low fat processed mint leaves incorporated herbal *paneer* spread. Mint leaf paste, dried mint leaves and mint oil were added to *paneer* spread at various levels i.e., 1 to 7 per cent, 0.5 to 2.5 per cent and 0.01 to 0.05 respectively. Incorporation of mint leaf paste in *paneer* spread significantly ($p \leq 0.05$) decreased total solids, fat, protein, dried mint leaves and mint oil incorporation significantly ($p \leq 0.05$) increased total solids, protein, ash, acidity, antioxidant activity, total phenols. Based on organoleptic evaluation, *paneer* spreads with 5 per cent mint leaf paste, 1.5 per cent of dried mint leaves and 0.01 per cent of mint oil were found highly acceptable. During storage in air-tight glass jars under refrigerated conditions (5±1°C), acidity and total plate count of all samples increased significantly ($p \leq 0.05$) with duration. The microbial counts were under acceptable limits and there was no growth of coliform bacteria throughout the storage period. The product was found to be microbiologically safe for15 days of storage.

Keywords: *Paneer* spread, mint, dried, paste leaf, mint oil etc.

PS 4.8 Wheatgrass as Potential Source of Nutrients

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Wheatgrass stands out as an appealing functional food with potential health benefits due to its remarkable qualities as a natural source of nutrients. Despite having a fantastic nutritional profile, it is nevertheless easily accessible and inexpensive, which intrigues researchers. But, being perishable in nature, it is essential to convert them into shelf-stable material, maintaining their physio-chemical, nutritional, optical, functional, and morphological properties. Thus, the present study was designed to investigate the effect of different harvesting time (8^{th} and 10^{th} days) and drying temperatures (45°C to 65°C with a regular interval of 10°C) on the nutritional properties of wheatgrass, including chlorophyll content and ascorbic acid content. The obtained results showed that the chlorophyll and ascorbic acid content of wheatgrass were significantly ($p< 0.05$) affected by the harvesting time. Moreover, the drying behaviour was found to be temperature-dependent and significantly affected the quality of the product. The optimum harvesting time and drying temperature were identified on the 10^{th} day at 55 °C, respectively. Moreover, wheatgrass was analysed for proximate composition, anti-nutritional factors, bioactive compounds, functional properties, physical properties, colour measurement, FTIR, SEM, XRD, and DSC. A significant ($p<0.05$) difference was observed in all the properties, but no major difference was found in the physical properties, which may be due to the similar particle size of the powders. It was observed that wheatgrass obtained from the black wheat variety was superior to all others. Being a powerhouse of nutrients, wheatgrass is referred to as a functional ingredient and can be used in the form of powder or juice to improve its nutritional value.

Keywords: Wheatgrass, Coloured wheat, chlorophyll, functional ingredient, drying, harvesting.

PS 4.9 Extraction of Soybean Meal Protein Isolates using Microwave Treatment and its Characterization

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Soybean meal is an agro-industrial byproduct generated from the soybean oil processing industry. Despite containing a huge quantity of protein approximately 45 - 50%, it remains underutilized and mostly used for animal feed. Hence, the extraction and value addition of this byproduct is highly important. In the present work, protein isolate was prepared by optimizing microwave treatment parameters from soybean meal, and its characteristics were studied. The maximum extraction yield (16.85%) and purity (92.5%) were obtained at the optimal microwave treatment conditions of 10:1 v/w, 600 W, and 30 s of liquid-solid ratio, power, and time respectively. The functional, structural, and thermal properties of soybean meal protein isolate (SMPI) were analyzed. Results indicated that SMPI extracted with microwave treatment showed better functional characteristics like solubility, emulsion capacity, and foaming capacity than the SMPI prepared without microwave treatment. The structural and thermal characteristics of SMPI studied through FTIR, XRD, and DSC also indicated that SMPI prepared with microwave treatment had better structural and thermal stability as compared to SMPI prepared without microwave treatment. This study demonstrated that microwave treatment causes desirable changes in protein characteristics that can be utilized for soybean meal protein-based novel food products.

Keywords: Soybean meal protein isolates, microwave treatment, functional property etc.

PS 4.10 Litchi seed (non-conventional starch Source): Impact of Different Solvents on Extraction Yield, Colour and Amylose Content of Starch

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Litchi seed (non-conventional starch source) is an agro-industrial waste generated during processing of litchi fruit into various food products such as beverages, jellies, squash etc. Mostly it is discarded without any values addition in-spite of containing 40% starch. The present work was aimed to evaluate the effect of different solvents on extraction yield, colour and amylose content of starch by conventional method. The extraction of litchi seed starch was conducted using different solvents like sodium bisulphite, sodium metabisulphite, sodium hydroxide, and citric acid by steeping litchi seed in ratio of (1:2). It was found that yield of starch containing sodium metabisulphite was highest i.e., 22.77%, followed by sodium bisulphate 20.40%, sodium hydroxide 12.86% and citric acid 10%, respectively. Colour of starch extracted by using sodium metabisulphite was whiter as compared to other solvent extracted starch. Amylose content of starch extracted using sodium metabisulphite showed highest value i.e., 31.07%, followed by sodium bisulphate 30.65%, sodium hydroxide 25.09% and citric acid 19%, respectively. The overall study suggested that sodium metabisulphite can be a better solvent for extraction of starch from litchi seed and its value addition for new product development.

Keywords: Agro-industrial waste, litchi seed, conventional method, starch extraction, amylose content.

PS 4.11 Protein-based Hydrogels: A Versatile Biomaterial for Food and Biomedical Applications

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Proteins are renewable resources derived from byproducts and residues of the livestock sector and agricultural industries. Proteins have been the subject of numerous in-depth research for usage in protein-based hydrogels. Further, accessible proteins are converted into hydrogels utilizing enzymes, chemicals, or physical techniques in order to enhance these dietary proteins in the diet as much as possible. Protein hydrogels are nontoxic, biocompatible, biodegradable, readily accessible, and renewable in addition to being inexpensive. To improve mechanical and functional qualities for particular applications, composite or hybrid hydrogels are created by combining proteins with polysaccharides and other biomolecules. These biomaterials' enhanced tensile strength as well as their ability for carrying and releasing biomolecules have also contributed to their rising popularity during the past few years. Thus, in addition to their potential to treat wounds and their usage in the food and agricultural industries, hydrogels can control the release of bioactive compounds and increase the bioavailability of such ingredients. This article thoroughly analyses basic polymer hydrogel categorization, diverse protein hydrogel forms, production techniques, physicochemical and functional properties, and applications in various fields. Therefore, will provide a comprehensive reference for the numerous aspects of protein hydrogels that are important to multiple academic and industrial disciplines.

Keywords: Biomaterial, protein-based hydrogels, biocompatible, biodegradable etc.

PS 5.1 Exploring the Potential of Ultrasonication in Extracting Roselle Calyx (*Hibiscus sabdariffa L.*) Bioactive Compounds

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Roselle plant (*Hibiscus sabdariffa L.*) was selected for its being large preference in relation to research on food and medicinal values. The infused calyx of Roselle is considered as agro-industrial waste. Among plant sources, edible flowers rich in health protective phenolic provide novel opportunities as ingredient and nutraceutical source. The focus of this work was to simulate and upgrade the extract quality of roselle calyx by using ultrasound assisted extraction (UAE). The optimized values of UAE obtained roselle calyx extract were yield of (48%), total phenolic content of (37.89 mg GAE/g), total flavonoid content of (29.86 mg QE/g), total anthocyanin content of (9.79 mg/g), and antioxidant activity (DPPH of 88.09%) respectively. The economic interest of Roselle lies in their calyx which are used more effectively to produce high value products including beverages, jellies, sauces, wines, liqueurs, and preserves; it is also used as a source of natural dye for food due to the presence of anthocyanins. In addition, roselle calyx extract enriched antimicrobial edible film/coating can be used as a promising candidate for dairy packaging applications. In future, controlled studies are required to investigate the effectiveness of different parts of Roselle under the various extraction conditions.

Keywords: Roselle calyx, Bioactive compounds, Anthocyanin, Ultrasound assisted extraction, Dairy applications.

PS 5.2 Silver Nanoparticles Incorporated Tardi (*Dioscoreabellophylla*) Starch-based Film

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Nanoparticles incorporated starch-based films have emerged as a promising and versatile class of coating materials with a wide range of applications across various food industries. In addition, the incorporation of nanoparticles imparts inherent antimicrobial properties to the films, rendering them effective in combating pathogens and maintaining hygiene in critical environments. Thus, this study aimed to develop varying proportions (0.5%, 1%, 1.5%, and 2.0%) of silver nanoparticles (AgNPs) incorporated Tardi (*D. bellophylla*) starch-based films using casting method and to evaluate their physicochemical, mechanical, morphological, and thermal properties. Results showed that the presence of AgNPs in the Tardi starch films significantly affected the film properties. Scanning electron micrographs (SEM) analyses and structural changes are shown by FTIR, which results in a slight shift of peaks due to AgNPs. In case of colour parameters, the controlled formulation films were colourless, whereas the nanoparticles incorporated films showed off white tint. The transparency of films was significantly ($p < 0.05$) decreased with the addition of AgNPs. Water vapour permeability and solubility decreased, and tensile strength increased as AgNPs concentration increased. Further, the films showed significant antimicrobial activity against selected gram-positive bacteria. The study thus reflects that this enhanced quality of film may find the application as coating material for fruit, vegetable, and dairy products in enhancing the shelf life.

Keywords: Tardi starch, silver nanoparticle, food coating, dairy application, antimicrobial properties

PS 5.3 Natural Fibre Based Biodegradable Packaging for Food and Dairy Products

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Natural fibre-based biodegradable packaging offers an eco-friendly and innovative solution for dairy and food product packaging, addressing mounting concerns about plastic waste and environmental pollution. Materials like jute, cotton, hemp, sisal, and bamboo present viable options for crafting such packaging. These plant-derived fibres possess a lignocellulosic composition consisting of essential elements like lignin, hemicellulose, and cellulose, making them renewable and biodegradable with minimal ecological impact compared to conventional plastics. Typically employed as reinforcement materials, natural fibres are enhanced through processes that reduce hydrophilicity and enhance adhesion, achieved by eliminating wax and increasing surface roughness. Chemical treatments such as alkaline solutions, oxidizing agents, and coupling agents boosts fibre strength, while physical techniques like cold plasma and steam explosion purify fibres, enhancing their stability. These fibres find applications as matrices, fillers, and reinforcements in food and dairy products packaging through methods such as solution casting, melt mixing, and injection molding, bolstering packaging strength. Biopolymers from sources like cornstarch and sugarcane can also be integrated to bind and strengthen fibres, resulting in customizable, low-carbon, and permeable materials. Ensuring packaging integrity by averting degradation reactions, controlling gas and water barriers, and upholding mechanical strength through suitable fiber selection and modification presents a challenge.

PS 5.4 Comparative Studies on Storage Life OF Piper Betel Leaves Added Ghee

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Ghee is a fat-rich concentrated dairy product originally produced in India. Though shelf life of ghee is can be extended by addition of synthetic antioxidant, however they have adverse health effect. Therefore, it is trend to use natural antioxidant like *Piper betel* leaves. The product without preservative (T_1) chemical preservative (T_2) and natural preservative *Piper betel* leaves (T_3) was stored at 50±1°C and packed similarly under aseptic condition in glass bottle. The product was examined at 15 days interval. Cow milk used for the preparation of ghee in present study contain an average 0.24 per cent fat moisture, 0.22 per cent free fatty acids content, nil peroxide value and TBA value, 0.6642 conjugated diene of cow ghee respectively and *Piper betel* leaves used for experiment reveals that the average chlorophyll content was 3.90 per cent, whereas average total phenolic content was 95.07 mg GAE/100g and antioxidant for 1000 sample concentration µg/ml was 62.64 respectively. The changes in sensory properties of the *Piper betel* leaves added ghee indicated that, as the storage prolongs the all properties were decreased significantly ($p<0.05$). The rate of changes in sensory was higher in control sample than other two sample. The chemical properties of the *Piper betel* leaves added ghee was also changed during storage. There was increased in moisture content, FFA, PV, TBA and conjugated diene from 0.24±0.002 to 0.62±0.008 per cent, 0.22±0.04 to 1.58±0.005 per cent (% oleic acid), 0.00±0.004 to 7.04±0.011 equiv/g, 0.00±0.004 to 1.80±0.006 OD and 0.67±0.004 to 1.98±0.012 per cent.

Keyword – *Piper betel* leaves, Ghee, Sensory Evaluation, Physico-chemical Evaluation

PS 5.5 Optimizing Milk Production: The Role of Evaporative Cooling in Dairy Farming

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The process involves circulating water through pipes or pads near the cows' resting and feeding areas. As air passes over these moist surfaces, it cools through evaporation, reducing the surrounding temperature. This cooled air is then distributed through the barn, creating a comfortable environment for the cows. The advantages of evaporative cooling are manifold. It helps maintain cows' body temperatures within the optimal range, improving their well-being and overall performance. Increased feed intake results in higher milk production. Moreover, these systems enhance air quality in the barn by removing dust, odours, and harmful gases. Additionally, evaporative cooling is energy-efficient, reducing electricity consumption and offering the option to use renewable energy sources. These systems are also easy to install and maintain, customizable to various dairy farm setups. In summary, evaporative cooling systems are a cost-effective and eco-friendly solution to mitigate heat stress, ensuring the comfort, productivity, and health of dairy cows while benefiting the environment and reducing operational costs in the dairy industry.

Keywords: Artificial neural network, yogurt, physicochemical characteristics prediction etc.

PS 5.6 Development and Performance Evaluation of On-farm Raw Milk Cooling System

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Despite the fact that many dairy farms in India have adopted clean milk production, the quality of raw milk produced at farm does not match that of raw milk produced in developed countries. The present study was conducted with an objective to develop raw milk cooling system of 300 L capacity for improving quality of raw milk produced at farm and delivered to dairies. The milk cooling system consisted of plate cooler, cooling cum storage tank and thermal storage system. Water/ice was used as a natural phase changing material for thermal storage so that peak load of the system can be reduced. The system uses chilled water for pre-cooling and final cooling of milk instead of direct expansion of refrigerant in the cooling cum storage tank. Hence, it requires less time to cool. The quality of milk was evaluated through various physico-chemical and microbiological tests. Traditional BMC system was used as a control. It was observed that the developed milk cooling system significantly improves raw milk quality. Such milk fetches good price, offers longer shelf-life and reduces energy demand for its processing.

Keywords: Raw milk, clean milk production, bulk milk cooler, longer shelf-life etc.

PS 5.7 Effect of Ultrasonicated Corn Starch on Quality of Curd

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Nowadays people are observed to be more health conscious than ever before, they are more concerned about their food habits and are trying to shift their lifestyle towards sustainable food systems. Therefore, increase in demand of low-calorie or low-fat foods is observed in the food market. As native starch has certain limitations such as syneresis, retrogradation properties, lack of viscosity etc., concept of starch modification comes in consideration to overcome these shortcomings. Starch in modified form can act as fat replacer and substitute fat globule to mimic their characteristics also act as texture improver. This study investigated the effect of ultrasonicated corn starch on quality of curd by the adding ultrasonicated corn starch in varied formulations from 0-5 per cent. Physical, proximate and sensory properties of curd were analysed. The instrumental data produced indicated that the firmness of curd samples increased significantly. Proximate parameters such as syneresis, pH and fat content decreased with addition of modified corn starch whereas titratable acidity and total solids were showing a reverse trend. The panelists gave favourable reviews to each of the curd sample made from ultrasonicated corn starch during the sensory test in comparison to control. Therefore, the investigation showed that modified starches are found to be potential functional ingredient thus leads to the formation of health foods like low-fat curd.

Keywords: Low-fat, Ultrasonication, modified starch, texture, curd etc.

PS 5.8 Assessment of Quality Characterization of Hemp Seed oil Based Nano-bio composite Film

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Industrial hemp commonly referred to as *Cannabis sativa* L. is a multipurpose crop that has numerous applications in nutraceuticals from the ancient period of times. Recently, the products of hemp have been employed in various packaging applications. Especially, due to their high dietary advantages, increased preference was shown for Hemp Seed Oil (HSO) among both the consumer and producer. The incorporation of HSO in the form of nanoemulsion into films prepared by employing natural polymers will significantly help to deliver the nutritional components. An ideal biopolymer has been chosen to evaluate the different emulsion concentrations (10, 8, 6, 5, 4, and 3%) for making the emulsion-incorporated edible film. While peeling, a brittle texture and weak behavior of the film were observed at greater concentrations of Hemp Seed Oil Nanoemulsion (HSONE). To improve the peeling-off qualities of films, a reduced concentration of emulsion @1%, along with potato starch (5%), glycerol (3%), and xanthan gum (0.1%), were added. This resulted in ideal finishing properties in the film. The resulting film showed a thickness of 0.141 mm; water solubility of 50.860 percent; water vapor transmission rate of 12.993 g/m^2h; transmittance of 86.793 percent; moisture content of 20.289 percent; water activity (a_w) of 0.480; and L*, a*, and b*, values of 27.913, -0.163, and -0.15, respectively. From the results obtained, it was concluded that the films prepared with the incorporation of HSONE may be useful for the packaging of various kinds of food and dairy products.

PS 5.9 Optimization of the Chocolate Conching Process in Developed Chocolate Conche

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Chocolate is a continuous phase of cocoa butter suspended in a fine solid solution of sugar, cocoa, and potentially milk solids. The process of making chocolate essentially involves a step known as conching which led to the final flavor and texture of the chocolate. The present study was planned to developed a suitable prototype for conching process of chocolate. The mechanical unit for the conching of the chocolate was conceptualized as a High Shear Prolong Mixing unit compressing of oil jacketed rotating kettle, custom-designed roller and scraping assembly, mechanical drive for roller and scraper assembly and control panel. The feasibility of custom design prototype was tested for optimization of process parameters namely roller speed, temperature during conching process and process time during conching process in Central Composite Rotatable Design (CCRD). The effect of process parameters on quality attributes of prepared chocolates was measured in term of its moisture content, particle size, color and overall acceptability and their interactive effect was also statistically measured. The optimized solution was obtained as Roller speed 75 RPM; process time 7 hours; temperature 76 ^{o}C. The optimized condition was validated with real time experiments using multiple trial under optimized condition and with the present developed unit it was possible to reduce the particle size of chocolate to less than 50µm under the optimized condition. The mechanical unit for chocolate manufacturing, was successfully demonstrated have potential for adoption by small scale food industries. The developed small conche was especially for small entrepreneurs and dairy farmers who wants to enter into business of chocolate processing.

Keywords: Chocolate, conching, conche, optimization, response surface methodology etc.

PS 5.10 Development of Amaranth Incorporated Composite Fermented Milk Drink (AICFMD)

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Fermented milk products are considered as a highly nutritious food containing a significant concentration of macronutrients, micronutrients and bioactive molecules required for the growth and overall development of people of all ages. However, they lack fibre and essential minerals like iron. Pseudo-cereals are principal sources of energy, carbohydrates, protein, fibre and micronutrients like calcium, phosphorus, potassium, zinc, iron etc. A composite milk product can be developed by adding flour of amaranth, quinoa and buckwheat into milk adds value to milk and confers health benefits to consumers. During the COVID-19 pandemic, consumption of mineral-rich composite fermented milk drinks is increased. Grain amaranth has gained more attention in the past few years due to its unique nutritional properties and versatile usage. Considering the above facts, attempts have been made to develop amaranth incorporated composite fermented milk drinks. The level roasted amaranth flour, sugar and surd acidity were determined using Response Surface Methodology (RSM) with Central Composite Rotatable Design. Composite fermented milk drink prepared from 60.5%, toned milk, 4%, amaranth, 10.5% sugar, 25.0% water (w/w) with curd acidity 0.831% LA and final total solid content maintained to 21.2%, resulted in good quality AICFMD that could be stored well up to 21 days after thermization without any preservatives. Though the developed AICFMD product had lower shelf life than control, it had a good source of calcium, phosphorus, magnesium, potassium, zinc and iron viz. 43, 31.75, 11, 7.3, 6.25 and 4 per cent DV per serving, respectively, with added advantages of good source fibre and nitrogen. Further, it had calcium: phosphorus ratio of 1:1.35 and was close to the nutritionist recommended ratio of 1:1.5

Keywords: Amaranth, fermented milk, thermisation, response surface methodology etc.

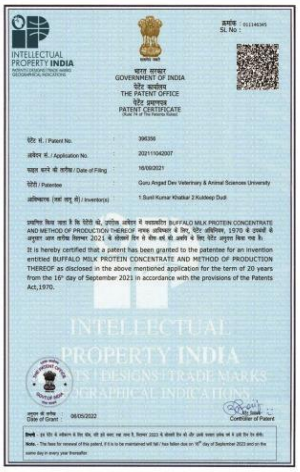
PCM BASED GADVASU MILK CHILLER

FEATURES

- Milk Chilling Time - 1-2 h up to 4^0C
- Temperature maintenance - 12 h at 4^0C
- Electricity Consumption - 2.1 Amp
- Compact in size and easy to operate
- Specially designed inlet for easy cleaning of machine
- Milk outlet for easy dispensing of milk

SPECIFICATIONS

- Capacity - 40 litres
- Power Source - Electricity or Solar Energy powered
- Material of Construction - Stainless Steel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THE PATENT OFFICE

PATENT CERTIFICATE

It is hereby certified that a patent has been granted to the patentee for an invention entitled BUFFALO MILK PROTEIN CONCENTRATE AND METHOD OF PRODUCTION THEREOF as disclosed in the above-mentioned application for the term of 20 years from the 16th day of September 2021 in accordance with the provisions of the Patents Act,1970.

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