



NDRI

News

Volume 20 No. 3 | Oct. – Dec., 2015

From the Director's Desk



**Inauguration of North-Zone
Students' Research Convention
'Anveshan' at NDRI**

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Milk from non-bovine species is recognized for the therapeutic value and nutritive richness. These have been reported to possess vital medicinal properties such as anticancer, antidiabetic, antiviral etc. It is, therefore, important to investigate the composition of milk of minor species, not only for their basic constituents but also for their vital health components. Goat milk is one such commodity, which is endowed with numerous health promoting ingredients and thus, has attracted wide attention round the globe. It has also played an important role in the nutritional security by providing essential amino acids and minerals to the people of developing countries where bovine milk is not readily available.

Goat milk has been considered as an ideal substitute for bovine milk, especially for populace suffering from cow milk allergy (CMA). Further, as compared to cow and human milk, goat milk possesses some distinctive biologically active properties, such as high digestibility, high buffering capacity, and a series of other therapeutic values in medicine and human nutrition. It has been reported that therapeutic and nutritional properties of goat milk come from its lipid part rather than proteins or minerals. Goat milk fat contains significantly greater contents of short and medium chain length fatty acids (C4:0 – C12:0). The fatty acid contents of goat milk fat significantly differ from that of cow milk fat, being much higher in butyric (C4:0), caproic (C6:0), caprylic (C8:0), capric (C10:0), lauric (C12:0), myristic (C14:0), palmitic (C16:0), linoleic (C18:2) fatty acids, but lower in stearic (C18:0), and oleic acid (C18:1). Capric, caprylic acids and medium chain fatty acids (MCT) have established their role in treatment of various health ailments. Goat milk proteins are also more readily digestible, and their amino acids are absorbed more efficiently than that of cow milk. Owing to the lower levels of α -casein in goat milk, it forms a softer and more fragile curd upon acidification. Goat milk contains higher amounts of essential amino acids mainly threonine, isoleucine, lysine, cystine, tyrosine and valine. As compared to cow milk, the level of cystine and tyrosine is 53 and 13% more in goat milk.

In human medicine, the hypoallergenic property of goat milk is also of great importance. Significant improvement has been reported in treatment of children suffering from cow milk allergy. Anecdotal literature describes the use of goat milk in hypoallergenic infant foods and foods for those who are suffering from various other allergies such as eczema, asthma, stomach ulcer, colitis etc. Goat milk has better buffering capacity and thus, it is useful in the treatment of ulcers. Research at NDRI, Karnal has demonstrated and validated that digestibility of goat and camel milk is better than that of cow and buffalo milk. The presence of smaller fat globules in goat and



camel milk may be one of the primary reasons for the same. Further, MCTs in goat milk have been shown to improve digestion and metabolism of lipids as well as treatment of lipid malabsorption syndromes.

The carbohydrates of goat milk closely resemble human milk and are distinctly different from that of cow milk as it has been shown to have 10 times higher oligosaccharides than cow milk. Owing to their ability to possess functional effects such as prebiotic and anti-infective properties, goat milk oligosaccharides have also enhanced nutritive value and importance in infant food. Goat milk has higher level of calcium, phosphorus, potassium, magnesium, and chlorides, and lower level of sodium and sulphur contents than cow milk. In addition to the inherent nutrients, goat milk also has ability to produce bioactive peptides upon protein hydrolysis. ACE inhibitory and antibacterial peptides have been reported from goat milk casein and whey. Further, there are many reports on the presence of mineral binding, anti-carcinogenic and antithrombotic properties of goat milk. Goat milk also has a significantly higher level of growth factor activity than that of cow milk.

Recent reports suggest the use of goat milk in the treatment of dengue fever. This has most probably been attributed to the presence of selenium, which is 27 times higher in goat milk as compared to cow milk and or antimicrobial bioactive peptides. However, this needs to be validated through clinical studies.

Despite all the beneficial virtues of goat milk, its production worldwide is still scanty, primarily because of the poor productivity of animals. In India, efforts are needed to improve the lactation length and yield of goat milk, through multidisciplinary scientific interventions. Further, the benefits of consumption of goat milk need to be validated through clinical studies. Research may also be initiated on fractionation and separation of goat milk bioactive components.

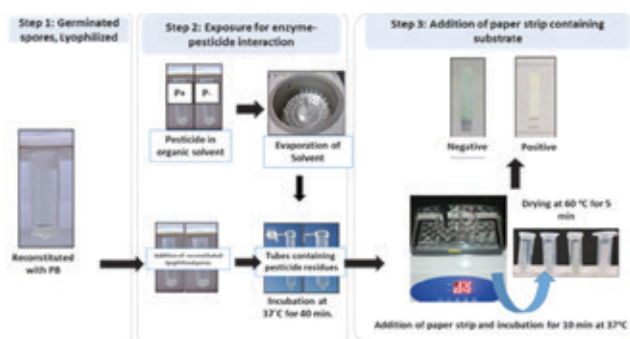
A. K. Srivastava
(A. K. Srivastava)

RESEARCH

Paper Strip Assay for Rapid Detection of Pesticide Residues

(N. Kumar, N. Tehri, R. Gopaul, P. K. Sharma, B. Kumar, S. Morab and H. V. Raghu)

Pesticides are well known carcinogens and their impact on human beings and presence in different food products including milk are well known. In the current work, spore based assay(s) which exploit the principle of "spore germination and enzyme inhibition" for detection of pesticide residues was successfully developed and miniaturized on 96 micro well plate and paper strip for their application under field conditions. Initially, expression of seven enzymes was evaluated in *B. megaterium* during spore germination and five enzymes were found to be expressed in presence of specific germinants. Further, a three step assay protocol, which involves spore germination; pesticide exposure; enzyme-substrate reaction, was developed as shown in Fig. Assay protocol optimized in tube was evaluated for enzyme inhibition with pesticides spiked in acetonitrile and LOD for organophosphorus (OP), carbamate (CM) and organochlorine (OC). The protocol was further transformed in a colorimetric 96 well plate assay and miniaturized on paper strip for exploring its potential for field application. Miniaturized assay(s) showed sensitivity in the range of 1-100ppb for OP, 10ppm for CM and 100ppm for OC pesticides. The specificity of developed assay(s) was evaluated for cross reactivity with antibiotics, aflatoxin, detergents, heavy metals, preservatives and sanitizers. A protocol for extraction of pesticides from milk was also optimized and linked with developed spore based assay (s). Shelf-stability of spores and substrates on paper strip was carried out upto 6 months. Developed spore based assay can be of immense use for food industry, R & D institutions and can also be applied under field condition.



Three step assay protocol for detection of pesticides on paper-strip

Expression and Purification of Buffalo Recombinant Interferon-Tau Protein

(Shrabani Saugandhika, Sudarshan Kumar and Dhruba Malakar)

Recombinant plasmid pET22b-BulFN-T was transformed into Top 10 cells and on analysis of the insert sequence ORF from positive clones, recombinant plasmid was isolated and transformed into *E. coli* BL21 (DE3) strain. Transformed BL21 *E. coli* cells when induced at 37°C and 25°C with 1 mM, IPTG, resulted in production of 20 kDa protein in the cell pellet fraction. The study revealed very low yield of recombinant BulFN-T in soluble fraction. Thus,

to improve the solubility of the recombinant BulFN-T, when 1.5 ml of transformed BL21(DE3) *E. coli* cells were induced at lower temperatures of 16°C and 12°C, the proportion of recombinant BulFN-T in soluble fraction increased to approximately 60–70%. Purification of the rBulFN-T through Immobilised Metal Affinity Chromatography (IMAC) resulted in two broad fractions-the eluted fraction during gradient of 300 mM Imidazole and the washing fraction (i.e. fraction collected during washing with 20 mM Imidazole wash buffer). Both fractions contained high amount of 20 kDa expressed protein. The washing fraction had very low level of contaminant proteins in comparison to eluted fraction. Eluted fraction was further purified by ion-exchange chromatography (IEX) using Q Sepharose Column. The Q Sepharose column elute was purified by Gel Exclusion Chromatography (GEC) using Sephadex G-100. The washing fraction obtained from IMAC affinity purification was also purified by GEC using Sephadex G-100. The western blot analysis using anti-his mouse antibody and horseradish peroxidase conjugated secondary antibody with Di-amino benzene (DAB) system as substrate showed a fine single interaction at 20 kDa protein. In conclusion, expression and purification of buffalo interferon Tau protein was successfully performed.

A Strip Based Test for Detection of Sucrose in Milk

(Priyae Brath Gautam, Rajan Sharma, Y. S. Rajput and Bimlesh Mann)

A rapid strip based test for detection of sucrose in milk has been developed. The developed strip test can detect 0.1% sucrose in milk. The working of the strip involves placing a drop of milk on the developed strip and observing the change in colour after 5 min. The strip is white in colour and in case of milk adulterated with sucrose changes to pink colour. The intensity of developed pink colour is proportional to extent of sucrose in milk. In case of pure milk, the strip retains its original white colour. The test is convenient to do and can be easily done at milk collection center as well as at house hold level. **The technology of the strip is available from NDRI on commercial basis.**



Figure: Working of the strip based test for detection of sucrose (at various levels) in milk

Patents Filed

- Rapid Spores-Enzyme based miniaturised assay(s) for detection of pesticide residues. (Naresh Kumar, Nimisha Tehri, Rajesh Gopaul, Pradeep Kumar Sharma, Brijesh Kumar, Spurti Morab, Raghu H. V.) 3810/DEL/2015.
- A process for Iron Fortification of Paneer using edible coating. (Narender Raju Panjagari, Parameshwar S. Jotarkar, Ashish Kumar Singh, Sumit Arora) 3926/DEL/2015.

Technologies Commercialized

S No	Name of the Technology	Inventors	Cost of the Technology (INR)	Date of purchase	Firm
1	Technology of Kheer Mohan Production from Buffalo Milk	Ganga Sahay Meena, Vijay Kumar Gupta, Yogesh Khetra, Raghu H.V. Ronak Shrimali	1,80,000 + 25,200 (14% ST) = 2,05,200/-	28.10.2015	Ramesh Chandra Garg Krishna Chilling Center, Wazirpur, Gangapur city Dist: Sawai Madhopur, Rajasthan- 322001

2	Misti Doi with fast acidifying high sugar tolerating lactic culture	Surajit Mandal, S.K. Tomar and Pradip V. Behare	1,60,000+ 23,200 (14.50% ST)= 1,83,200/-	7.11.2015	ITC LIMITED No.18, Banaswadi Main Road, Maruthiseva, Nagar, Bangalore-560 005
Total Amount (INR)			3,40,000/- + (ST) 48, 400/- = 3,88,400/-		

EXTENSION

DAIRY EXTENSION DIVISION

Extension Activities

- Dairy Extension Division organized the ongoing Extension Education Programme "Dairy Education at Farmers' Door" to strengthen the effective dissemination of dairy production and processing technologies among farming community. Under this programme, a team of NDRI scientists including subject matter specialists from production, processing and management group visited a new cluster of villages viz., Gunto, Diplo and Dungro in Karnal district on 2nd Saturday of every Month during the period under report. Extension scientists obtained the feedback from the participating farmers. The key points of interactions were anestrus in cows, adulteration in milk and management of advanced pregnant animals. Besides treatment of affected cows, the farmers were advised about management practices for improving milk production. The farmers were also educated about the clean milk production and measures to check adulteration in milk.
- The Field/Farm Technician (FFT) Laboratory of Dairy Extension Division provides a base for extension work in the adopted villages around Karnal and keeps the records of all extension activities of the Division. In all, 8 Veterinary Camps and 198 cases were treated for various veterinary ailments. Special attention was given to improve the productive & reproductive performance of dairy animals. Eight Kisan sangosthies were organized at village level.
- Seven women empowerment training and campaigns were organized for 143 farm women with the objective to create awareness in the field of dairying and home science and also impart skill in these areas so that farm women could generate more income from dairying.
- A total number of 1847 visitors (students & Faculty) from 29 colleges/Institutions/Universities visited the institute. The groups were sensitized about the different research, teaching and extension achievements and facilities available in the Institute.

KRISHI VIGYAN KENDRA

Field Activities

- A "Women in Agriculture" day was celebrated in village Beed Narayana, Dist Karnal on 5th December, 2016.
- A programme on "World Soil Day" was organized to distribute the soil health cards at KVK, NDRI, Karnal on 5th December 2015. Approx. 250 farmers and farm women participated in the event.
- Two programmes were organized to celebrate "Jai Kisan Jai Vigyan" divas on 23rd and 26th December, 2015 at Sansad Adarsh Gram village Mohiuddinpur and NDRI Karnal, respectively. The programme at NDRI was presided over by Dr. A. K. Srivastava, Director, NDRI Karnal. About 240 farmers, rural youth and farm women participated in these programmes.



Dr. A. K. Srivastava, Director NDRI addressing the farmers on "Jai Kisan Jai Vigyan" divas

Extension Activities

- A total of 53 training programmes (On-campus, Off-campus & study-cum-visits) on different aspects of dairy production and processing, crop production, crop diversification and home science were organized, in which 1657 farmers, women and rural youth from Haryana and other states of the country were imparted trainings.

- KVK also organized 24 exposures cum study visits for 732 progressive farmers and farm women from different districts of Uttar Pradesh, Madhya Pradesh, Punjab, Gujarat, Rajasthan, Haryana, Odisha and Arunachal Pradesh, besides a group of 9 foreigners from Kenya were explained and shown the Institute, KVK and field activities.
- Various Animal Health Management activities were organized through Stockman centers in adopted villages

of KVK. At these centers, 293 cattle and 340 buffaloes were artificially inseminated and 231 calves were born. Besides these, 25 calves were dehorned.

- KVK conducted 169 demonstrations in various villages of Karnal district to popularize the latest released varieties of various crops and to promote crop diversification, during Rabi season.

EVENTS

NDRI Paid Tribute to Gandhi ji by Organizing Massive Cleaning Drive

To commemorate the birthday of Mahatma Gandhi, NDRI organized a cleaning campaign on massive scale. Under the leadership of Dr. A. K. Srivastava, Director, NDRI, more than 1200 employees of this Institute took the task to clean the every nook and corner of 1400 acre area of NDRI. More than 1000 students also participated in this cleaning drive. Residents of NDRI were sensitized for making their surroundings clean.

ICAR Winter School on Current Concepts and Frontier Technologies for Fertility Management in Farm Animals

An ICAR sponsored winter school on "Current Concepts and Frontier Technologies for Fertility Management in Farm Animals" was organized from 5th - 25th October, 2015. The training programme was attended by 22 participants working in various agricultural universities as Assistant Professors, Associate Professors and Subject Matter Specialists representing 12 states of the country. The winter school exposed the participants to the recent developments in the area of reproduction management and provided updated knowledge on frontier technologies for improving reproduction efficiency in male and female farm animals.



A Compendium of lectures being released

The programme was inaugurated by Dr. Suresh S. Honnappagol, Animal Husbandry Commissioner, Govt. of India. He informed that production largely depends upon reproduction, and successful reproduction with optimum reproductive efficiency is the major factor determining the farm efficiency and profitability.

Dr. Srivastava, Director, NDRI opined that to meet the rising demand for livestock products, the productivity and life-time

production need to be improved substantially. However, delayed sexual maturity, extended calving to conception interval and poor conception rate continue to remain as major problems in considerable population of animals leading to reduced life-time production.



Dr. A. K. Srivastava, Director, NDRI giving away certificates to the participants

National Training on Instrumentation Involved in Quality Assurance of Milk and Milk Products

The Centre of Advanced Faculty Training in Dairy Processing organised a National Training programme on 'Instrumentation involved in Quality Assurance of Milk and Milk Products' for the teaching faculty of State Agricultural Universities and ICAR Institutes from 3rd - 23rd October, 2015.



A CD containing lectures being released

All India Animal Husbandry Officers' Workshop

A four day All India Animal Husbandry Officers' Workshop cum Training Programme on "Enabling Extension Functionaries to Address Field Level Problems in Animal Husbandry" was organized from 26th -29th October, 2015 in collaboration with MANAGE, Hyderabad. This workshop was inaugurated by Dr. V. K. Taneja, former-DDG, Animal Science, ICAR & former-VC, GADVASU, Ludhiana, Punjab. Dr Taneja emphasized on the necessity of dairying and animal husbandry being the source of livelihood and nutritional security for the masses of our country, especially at the ground level. The main objectives of this programme were to lay emphasis on capacity building of field functionaries in the recent developments in the dairy sector, to disseminate the latest technologies, innovations and extension methodologies for effective transfer of scientific information to the stakeholders as per their needs as well as to the states and to discuss the emerging problems and issues of dairying under field conditions with the scientists of research institute / Universities and develop strategies to handle these field related problems. Thirty seven delegates from the 14 states attended this programme. The certificates were given to participants by the Ms. V. Usha Rani, IAS, Director General, MANAGE, Hyderabad and Dr. A. K. Srivastava, Director, NDRI, Karnal.



A view of inaugural session of Workshop

Ms.V. Usha Rani said that extension functionaries encounter many problems while dealing with the farmers such as price fixation for milk, adulteration of dairy products, escalating input costs, climate change effect, subsidies/incentives, migration of population to cities etc.



Ms. V. Usha Rani, IAS, Director General, MANAGE, Hyderabad addressing extension functionaries

Winter School Training Programme on Advanced Techniques and Novel Approaches for Quality and Safety Evaluation of Dairy Foods

A 21 day winter school was organized by NDRI, Karnal on the theme "Advanced Techniques and Novel Approaches for Quality and Safety Evaluation of Dairy Foods" from 17th November to 7th December, 2015. The training programme was attended by 24 participants from 12 states working as scientists in research institutes or as Assistant Professors/Associate Professors in various Agricultural Universities.

Speaking on the occasion, Dr. A. K. Srivastava, Director NDRI said that food testing is an essential and vital part for the growth of food processing industry to meet the challenges of food safety and consumer demands.

India's food processing sector has grown at an average of 8.4% during last five years and **parallel to the growth of the food processing industry, food testing industry is also growing.** He informed that India is facing shortage of food testing laboratories and currently, there are about 150 food testing labs in India which means for every 90 lakh persons, there is one laboratory.



Dr. A. K. Srivastava, Director, NDRI inaugurating the programme by lighting the ceremonial lamp

At the valedictory function, Dr. Sushil Kumar Saxena, Director and CEO Export Inspection Council (EIC) of India talked about trends in food safety and quality with special reference to import and export of food products. Dr. R. K. Malik, Joint Director (Res.) stressed about processing of food products as annually a large quantity of food gets wasted due to lack of processing.

Besides 45 theory and 23 practical lectures, a total number of 9 guest lecturers were also delivered during the entire training course.

Workshop on Climate Resilient Livestock Management System

A workshop was organized on "Climate Resilient Livestock Management System" on 20th November 2015. The workshop was inaugurated by Sh. Amarendra Singh, OSD to Chief Minister, Haryana. Sh. P. C. Chaudhri, Chief General Manager, NABARD (National Bank for Agriculture and Rural Development) was Chief Guest and Dr. A. K. Srivastava, Director, NDRI presided

over the function. The main objective of the workshop was to develop strategies to reduce thermal stress in livestock that cause fertility losses and other health related consequences to livestock. About 150 experts from agriculture, animal nutrition and progressive farmers attended the workshop.



Dr. A. K. Srivastava, Director, NDRI felicitating Sh. P. C. Chaudhari, Chief General Manager, NABARD



Sh. Amarendra Singh, OSD to CM, Haryana planting sapling at NDRI campus

Model Training Course on Capacity Building of Extension Functionaries on Climate Resilient Livestock Farming

An eight day Model Training Course on "Capacity Building of Extension Functionaries on Climate Resilient Livestock Farming" was organized from 26th November to 3rd December, 2015. The course was sponsored by the Directorate of Extension, Ministry of Agriculture and Farmers' Welfare, GoI. It was inaugurated by Dr. Harjinder Singh, Director, Massey Institute of Food science and Technology, Massey University, New Zealand. A series of lectures and practical sessions were organized covering various vital aspects of climate resilient livestock farming. The focus of the course was on implementation of sound practices on farms for maintaining the level of production and ensuring regular income from the farms in the wake of climate change and climate variability impacts. The model training course was attended by twenty two participants, nominated by the State Departments of Animal Husbandry and Dairy Development Departments from Andhra Pradesh, Kerala, West Bengal, Odisha, Meghalaya, Sikkim, NCR of Delhi and Haryana.



A compendium of lectures being released

National Milk Day Celebrated

NDRI celebrated 93rd Birth Anniversary of Dr. Varghese Kurien, the father of white revolution in India, on the National Milk Day on 26th November 2015. On this occasion, Prof. Harjinder Singh, Distinguished Professor and Co-Director, Riddet Institute & Director Massey Institute of Food Science & Nutrition, Massey University, Palmerston North, New Zealand delivered a very useful lecture of great practical importance on "Iron binding properties of milk: A new way to fortify foods". He spoke on the new technologies developed at his University for fortifying the dairy foods with iron. He emphasized that this would help in combating the iron deficiencies in human beings particularly in women and children in various parts of the world.

Prof. Dr. A. K. Srivastava, Director & Vice Chancellor, NDRI presided over the function. In his presidential address, he said that 80% of women of reproductive age in India suffer from iron deficiency. The technology developed by Prof. Singh would be helpful in this direction to overcome the problem of iron deficiencies in India. Paying tribute to Dr. Kurien, he said that we have to carry forward the work of Dr. Kurien as still in India only 7-8% of milk is processed in the co-operative sector. For the benefit of dairy farmers, the percentage of milk handled in co-operative sector has to increase.



Prof. Harjinder Singh Distinguished Professor Co-Director, Riddet Institute & Director Massey Institute of Food Science & Nutrition, Massey University, Palmerston North, New Zealand delivering lecture on the 'National Milk Day'

Dr. R. K. Malik, Joint Director (Res.) paid the tribute to Dr. Kurien by explaining the work carried by him for the upliftment of poor dairy farmers of the country. On this occasion, two scientists from University of Queensland, Australia, Dr. Bhesh Bhandari and Dr. Sangeeta Prakash also shared their thoughts and research work being carried out to make the dairy products more nutritious.

National Training Programme on Designing New Age Dairy Foods

A 21 day National Training Programme on “Designing New Age Dairy Foods” was organised under the aegis of Centre of Advanced Faculty Training in Dairy Processing at NDRI from 28th November to 18th December, 2015. Dr. R. K. Malik, Joint Director (Research), inaugurated the programme. The training programme was attended by 21 participants from eight states, working in various Agricultural Universities and ICAR Institutes as Assistant Professors/Associate Professors and Scientists.

Speaking on this occasion, Dr. R. K. Malik, Joint Director (Res.) said that designing criteria for dairy based functional foods and nutraceuticals needs a very clear understanding of complex food formulations, appropriate technologies, quality assessment and validation of functional claims. Therefore, it is essential that faculty and researchers who are involved in human resource development for the food industry, are also tuned to the changing trends and demands of consumers so that they can impart quality education to the future managers of the food industry.

Dr. Latha Sabikhi, Head, Dairy Technology Division and Director of Centre of Advanced Faculty Training in Dairy Processing said that new food formulations have to be designed in such a way that they provide all needy services to the consumers.

Short Course on Cross Breed Male Infertility and Bovine Genomics

A Short Course on “Cross Breed Male Infertility and Bovine Genomics” was organised at NDRI, Karnal during 8th – 17th December, 2015. The objective of this short course was to enhance the knowledge and expertise of researchers working on the vital aspects of animal biotechnology such as bovine genome organization, genetic cause of male infertility, genetic incompatibilities, interspecies cross and hybrid sterility in mammalian species and bovine transcriptomics with a key goal to understand the various domain of male infertility in cross breed bulls.



A compendium of lectures on “Cross Breed Male Infertility and Bovine Genomics” being released

Director, NDRI reiterated that with the help of technological advancement in animal biotechnology, newer genetic leads are established to understand the genetic causes of male infertility and genetic incompatibilities in cross breeds. Availability of genomic information on bovine and leads on functional genomics has provided the multiple ways to gain insight into biology of the animals.

The training programme was attended by 15 participants working in various Agricultural Universities, ICAR Institutes as Assistant Professors, Associate Professors and Scientists.

Institute – Industry Meet-2015

The technologies developed by scientists at NDRI were presented before officials from different industries as well as to the entrepreneurs at the Institute – Industry Meet organized on 17th December, 2015. Apart from NDRI, other zonal Institutes of NDRI such as NBAGR, CIRG, NRC on camel, NRC on Equines also presented their technologies to the Industries. In total, about 100 technologies were presented to the industries. In the Meet, there was industrial participation from Nestle India Ltd.; Mother Dairy, Delhi; GlaxoSmithKline; National Dairy Development Board; Modern Dairies, Karnal; Neugen Diagnostic, Secunderabad; Madhu Dairy, Bihar; etc.

North Zone Students Research Convention (ANVESHAN-2015)

With a view to inculcate research culture in our higher education institutions, the **Association of Indian Universities (AIU), New Delhi** has taken a pioneering initiative to organize Student Research Conventions for the aspiring researchers throughout the country.

In this regard, the Zonal Event (North Zone) of **ANVESHAN-2015: The Student Research Convention** was organized by NDRI, Karnal during 28th – 29th December, 2015. Eighty five research scholars representing 20 Universities from Jammu & Kashmir, Punjab, Haryana, Uttarakhand, Himachal Pradesh and Uttar Pradesh attended the convention.

The convention was inaugurated by Dr. Gurbachan Singh, Chairman, Agricultural Scientists Recruitment Board (ASRB), New Delhi. Dr. Singh addressed the budding researchers and motivated them to carryout research that brings laurels to their respective Institutes and the nation. The function was presided over by Prof. A. K. Srivastava, Director & Vice Chancellor, NDRI, Karnal. Prof. Srivastava cited examples of accidental research discovery of Penicillin antibiotic and motivated the scholars. Dr. R. K. Malik, Joint Director (Res.), NDRI, Karnal welcomed the Chief Guest, participants and others dignitaries present in the programme.

The competitions were held in two stages under five categories viz. Basic Sciences, Agricultural Sciences, Engineering & Technology, Health Sciences and Allied Subjects, Pharmacy, Nutrition, etc. and Social Sciences, Humanities, Commerce and Law. In the first stage, all the participants presented their research posters, out of which, about 50% of research projects under each category were shortlisted for oral presentations. Finally based on their overall performance, best three projects from each category were selected and nominated for National

level competitions by a team of experts comprising of eminent professors and scientists from different R&D institutions and academia.

Training on Milk and Milk Processing organised by BPD Unit

A training programme on Milk and Milk Processing was conducted from 14th – 19th December, 2015 at NDRI Karnal. Fifteen participants from different parts of the country joined the training with great enthusiasm to start their own ventures in the Indian Dairy Market. The processing aspects

of various milk and milk products were covered alongwith quality and safety aspects prevailing in the country (FSSR, 2011). MS-Excel based calculation formula sheets were distributed to the participants that helps in product formulations, optimization and minimization of milk solids loss. Participants interacted with dairy equipment manufacturing firms to facilitate the procurement and establishment of dairy plant machinery for processing of milk and milk products at various levels.

HONOURS/AWARDS

Dr. A. K. Srivastava, Director and Vice Chancellor, NDRI was conferred “**Doctor of Science (Honoris Causa)**” for his significant contributions made in the field of Veterinary

and Animal Sciences by Pandit Deen Dayal Upadhyay Pashu Chikitsa Vigyan Vishaw Vidyalaya, Mathura on 17th November, 2015.



Dr. A. K. Srivastava, Director NDRI receiving degree of “Doctor of Science (Honoris Causa)” at PDDUPCVV, Mathura

Dr. A. K. Srivastava, Director and Vice Chancellor, NDRI received an award for “**Outstanding Contribution to Education**” by Dewang Mehta Education Foundation on 28th November, 2015, at Mumbai.

DISTINGUISHED VISITORS

- 16.12.2015 A 26 member delegation of Senior Agricultural Policy Makers, Researchers and other Stakeholders from Afghanistan.
- 17.12.2015 Sh. Sunil Kumar Singh, Hon'ble AS & FA, Department of Agricultural Research & Education, ICAR, New Delhi.

PERSONALIA

Joining/Appointments

- Dr. Amrish Kumar Tyagi, Principal Scientist appointed as Head, Dairy Cattle Nutrition Division at NDRI, Karnal w.e.f. 28.10.2015.
- Dr. (Mrs.) Smita Sirohi Principal Scientist appointed as Head, DES&M Division at NDRI, Karnal w.e.f. 28.10.2015.
- Dr. A. K. Singh, Principal Scientist appointed as Acting Head of Dairy Engineering Division at NDRI, Karnal w.e.f. 01.11.2015.
- Dr. Rajalaxmi Behra, Scientist (Animal Genetic & Breeding) joined at ERS of NDRI, Kalyani w.e.f. 09.10.2015.
- Ms. Vairat Amita Dinkar, Scientist (Agricultural Process Engineering) joined at NDRI, Karnal w.e.f. 12.10.2015.
- Sh. Umesh Chandra Sharma, AAO, IARI, New Delhi joined at NDRI on promotion to the post of Administrative Officer w.e.f. 05.11.2015.
- Dr. Raman Malik, Principal Scientist joined at NDRI, Karnal after transfer from ICAR-CIRB Sub Campus, Nabha (Punjab) under ICAR- Central Institute for Research on Buffaloes, Hisar w.e.f. 16.11.2015.
- Ms. Monika Sharma, Scientist (Food Technology) joined at SRS of NDRI, Bangalore after transfer from ICAR-Central Institute of Post Harvest Engineering & Technology, Ludhiana w.e.f. 01.12.2015.

- Sh. Ram Niwas Panchal, AO joined at NDRI Karnal after transfer from IVRI, Barielly w.e.f. 18.12.2015.

Promotions

- Sh. Somenath Dutta, ACTO, ERS of NDRI, Kalyani promoted to the post of CTO w.e.f. 23.08.2013.
- Ms. Janakshi, TO, SRS of NDRI, Bangalore promoted to the post of STO w.e.f. 12.07.2014.
- Sh. Chaman Lal, TO, Livestock Research Centre promoted to the post of STO w.e.f. 08.10.2014.
- Sh. K. P. Lakshminarayanappa, TO, SRS of NDRI, Bangalore promoted as STO w.e.f. 29.10.2014.
- Sh. Meghanathan, TO, Southern Regional Station of NDRI, Bangalore promoted to the post of STO w.e.f. 29.10.2014.
- Sh. Deshwart Sharma, Ex-TO, KVK promoted to the post of STO w.e.f. 01.01.2015.
- Sh. Prem Singh, STO, Estate Section promoted to the post of ACTO w.e.f. 01.01.2015.
- Sh. Y. K. Panwar, TO, Dairy Cattle Breeding Division promoted to the post of STO w.e.f. 01.01.2015.
- Sh. Shish Pal Gupta, TO, Human Health Complex promoted to the post of STO w.e.f. 01.01.2015.
- Sh. Sidhu Purthy, STA, Dairy Microbiology Division promoted to the post of TO w.e.f. 01.01.2015.

- Sh. Mangey Ram, STA, Animal Biotechnology Centre promoted to the post of TO w.e.f. 01.01.2015.
- Sh. Des Raj, STA, Computer Centre promoted to the post of TO w.e.f. 01.01.2015.
- Sh. Kumar Bharat, STO, ATIC promoted to the post of ACTO w.e.f. 01.01.2015.
- Sh. Ravi Kant, STO, Animal Biochemistry promoted to the post of ACTO w.e.f. 09.01.2015.
- Sh. Gurpartap Singh, STA, Experimental Dairy Plant promoted to the post of TO w.e.f. 14.01.2015.
- Dr. S. Raju, ACTO, Animal Health Complex promoted to the post of CTO w.e.f. 17.02.2015.
- Sh. Ashok Kumar, STA Farm Section promoted to the post of TO w.e.f. 06.03.2015.
- Sh. Kulvir Singh, STO, KVK promoted to the post of ACTO w.e.f. 12.05.2015.
- Sh. K. Ningaraju, TO, Southern Regional Station of NDRI, Bangalore promoted to the post of STO w.e.f. 06.06.2015.
- Dr. V.R.V. Surendranath Naik, Chief Technical Officer (M&PM) Southern Regional Station of NDRI, Bangalore granted one advance increment w.e.f. 29.06.2015.
- Sh. K. L. Sampath, STO, Southern Regional Station of NDRI, Bangalore promoted to the post of ACTO w.e.f. 01.07.2015.
- Sh. Mihir Lal Ghosh, STO, Eastern Regional Station of NDRI, Kalyani promoted to the post of ACTO w.e.f. 01.07.2015.
- Sh. Subhash, Assistant promoted to the post of AAO at NDRI, Karnal w.e.f. 10.11.2015.
- Sh. Satpal Hans, Assistant promoted to the post of AAO at NDRI, Karnal w.e.f. 12.11.2015.
- Sh. R. K. Bansal, AAO promoted to the post of AO at NDRI, Karnal w.e.f. 31.12.2015.

Retirements

- Dr. K. K. Datta, Principal Scientist, Dr. Ish Kumar Sawhney, Principal Scientist and Mr. A. K. Sharma, CTO, Experimental Dairy, NDRI, Karnal retired from Council's service on 31.10.2015.
- Sh. Ram Shankar Gautam, Deputy Director (OL), Smt. Shulkla Virmani, Private Secretary and Mr. Gian Singh,

ACTO, Computer Centre retired from Council's service on 31.12.2015.

Transfers

- Sh. A. K. Barapatre, AAO transferred from NDRI, Karnal to NRCE, Hisar on promotion to the post of AO and relieved on 15.10.2015.
- Sh. Sathish Kumar. M. H., Scientist, transferred from NDRI, Karnal to SRS of NDRI, Bangalore and joined his duty on 19.10.2015.
- Dr. Laxmana Naik N., Scientist, transferred from NDRI, Karnal to SRS of NDRI, Bangalore and joined his duty on 21.10.2015.
- Sh. Ram Niwas, AAO transferred from NDRI, Karnal to IVRI, Barily on promotion to the post of AO and relieved on 04.11.2015.
- Shri. G. G. Harakangi, Chief Administrative Officer, transferred alongwith post from SRS of NDRI, Bangalore to Indian Institute of Horticulture Research (IIHR), Hesarghata, Bangalore and relieved on 16.11.2015.
- Dr. R. Senthil Kumar, Scientist (Vet. Extn. Education) transferred from NDRI, Karnal to ICAR-CIAE, Regional Center, Coimbatore and relieved on 21.11.2015.
- Dr. Anand Laxmi, Principal Scientist transferred from NDRI, Karnal to ICAR- Directorate of Polutary Research, Hyderabad and relieved on 07.12.2015.
- Dr. Asif Mohammad, Scientist transferred from NDRI, Karnal to ERS of NDRI, Kalyani and relieved on 15.12.2015.

VISIT ABROAD

- **Dr R. K. Malik, Joint Director (Research) and Dr. Surajit Mondal**, Scientist visited Riddet Institute, Massey University, Palmerston North 4442 from 22nd October to 4th November, 2015 under the DST funded Indo-NZ project: **"Development of Resilient Probiotic Foods Designed for the Indian Market Conditions"**.
- **Dr A. K. Srivastava, Director NDRI and Dr A. K. Tyagi**, Head, Dairy Cattle Nutrition Division were deputed as expert members to Michigan Biotechnology Institute, MSU, USA from 2nd – 5th December, 2015 to develop long term collaborative research and development programmes for **"Biomass Upgrading Technologies for Animal Feed and Fodder in India"**.

SOUTHERN REGIONAL STATION, BANGALORE

Extension Activities

- Eighteen Trainees of ABT Industries, Coimbatore, Hatsun Agro Products Limited, Chennai and a group of entrepreneurs underwent Training on Technology and Production of Cheddar and Processed Cheese and related products.
- Advisory services/technical advice on establishing a dairy processing unit, know-how of indigenous dairy products, training programmes on commercial dairy farming,

information on indigenous dairy animals & to set-up a new dairy farm were imparted to needy clients.

- Under the 'Dairy Education at Farmers' Door' programme, Bellikere, Muthasandra and Thiruvarama villages of Bangalore South district were visited and farmers were given technical advice on scientific dairy farming, green fodder production, clean milk production and dairy animal management aspects to the farmers and farm women at their doorsteps.

EVENTS

Gandhi Jayanti and Swachh Bharat Abhiyaan: Gandhi Jayanti was celebrated on 2nd October, 2015. All the Staff members & students assembled in Gandhi Park and saplings were planted in the Institute premises as a part of clean and green NDRI.

World Food Day: World Food Day was celebrated on 16th October, 2015 on the theme 'Protection and Agriculture – Breaking the Cycle of Rural Poverty'. Food Quiz, Poster Painting contest and Food Judging events were conducted for the Students. The function was graced by eminent Social Scientist Dr. K. Narayana Gowda, Former Vice Chancellor, UAS, Bangalore as chief guest of the function and Dr. B. V. Venkateshaiah, Former Dean, Dairy Science College, KVAFSU was the Guest of Honour. Prizes and certificates were distributed to the winners of these events.

National Milk Day: In order to commemorate the birth anniversary of Dr. V. Kurien, popularly known as father of white

revolution in India, a function was organized on 26th October, 2015. Dr. P. A. Shankar, Former Director (PGS), KVAFSU, Bidar and Dr. B. V. Venkateshaiah, Former Dean (PGS), KVAFSU, Bidar were Chief Guest and Guest of Honour, respectively. The programme was organized under the aegis of IDA SZ, Alumni Association and SRS of NDRI.

National Integration Day & Kannada Rajyotsava: National integration day & Kannada Rajyotsava was organized on 28th November, 2015. Dr. Anasuyadevi, Noted Kannada Writer was the Chief Guest and Dr. R. Bhatta, Director, NIANP, Bangalore was the Guest of Honour. Many sports, cultural and literary competitions were conducted.

Visit of Dignitaries: Mr. Vijay Intodia, US Embassy visited the Station on 23rd September, 2015 and interacted with all the Scientists of the Station.

EASTERN REGIONAL STATION, KALYANI

RESEARCH

Development of Caprine Embryo after In Vitro Maturation and Fertilization of Oocytes Using Cryopreserved Black Bengal Buck Semen

(Rohit Kumar, Prakash Chandra, Pangdum Konyak, M. Karunakaran and Subrata K. Das)

Attempt was made to develop embryo using *in vitro* matured oocytes collected from slaughter house ovaries and fertilized with *in vitro* capacitated cryopreserved Black Bengal buck semen. Goat ovaries were collected from local abattoir, Kolkata and brought to the laboratory in normal saline supplemented with streptopenicilline maintaining 30-35°C. Cumulus oocytes complexes (COCs) were isolated and washed thoroughly in washing media (TCM-199 + 10% FBS + 27 µg/ml Sod. Pyruvate + 50 µg/ml gentamycin) followed by maturation media (Washing media + 5 µg/ml FSH-P + 5% Follicular fluid). Then groups of 10-20 COCs were placed in 50 µl droplets of maturation medium, covered with sterile mineral oil in a 35 mm petri dish and incubated for 28 h at 38.5°C in a 5% CO₂ incubator with maximum humidity in air. After 28 h of incubation, COCs were inseminated with *in vitro* capacitated sperm suspension prepared from four days refrigerated preserved buck semen straws and allowed for fertilization in FBO media. After 18 h presumptive embryos were washed and kept in RVCL media for cleavage. After 40-42 h the cleaved oocytes were placed in replacement media for further development. The media was replaced after every 24 h with fresh replacement media.

Effect of Some North-Eastern Indian Tree Leaves on Ruminal Methanogenesis In Vitro

(M. Lotha, A. Santra, Subrata K. Das, A. Mandal and T. K. Dutta)

North-eastern part of India possesses a wide variety of tree leaves, which are not yet tested to observe their effect on ruminal methanogenesis. Eight tree leaves e.g., Agar (*Aquilaria agallocha*), Sonal (*Cassia fistula*), Polita mother (*Erythrina variegata*), Glyricidia (*Glyricidia maculata*), Barun (*Crataeva*

nurvala), Kamela (*Mallotus philippensis*), Harbarai (*Phyllanthus acidus*) and Nageswar (*Mesua ferrea*) were collected from Lembuchera, Tripura for studying their effect on ruminal methanogenesis *in vitro*. 200 ± 5 mg of each tree leaves were incubated anaerobically in triplicate with 30 ml buffered rumen inoculum (10 ml cattle rumen fluid + 20 ml buffer) in 100 ml calibrated glass syringes for 24 h at 39°C, with recording of the gas production after 24 h of incubation.

Methane emission per unit of digested dry matter was the lowest (P<0.01) in kamela tree leaves incubated group (21.8 ml/g DDM/24h) followed by nageswar (28.5 ml/g DDM/24h) and harbarai (34.1 ml/g DDM/24h) incubated groups. Percentage of methane in total gas was the highest in nageswar (24.9%) followed by harbarai (24.7%) and barun (24.0%) tree leaves incubated group, while it was the lowest in kamela tree leaves (21.5%) incubated group. It was concluded from the study that kamela (*Mallotus philippensis*) tree leaves might be used as feed additives to manipulate rumen fermentation for reducing ruminal methanogenesis.

EVENTS

Workshop cum Scientists' Dairy Industry Partners' Meet

A one day workshop cum Scientists' Dairy industry Partners' Meet on "Commercialization of Dairying through Production and Traditional Processing" was organized by ERS-NDRI, Kalyani in association with Faculty of Dairy Technology, West Bengal University of Animal & Fishery Sciences, BCKV, Mohanpur, W.B. on 12th December, 2015. The workshop was presided over by Prof. (Dr.) Purnendu Biswas, Vice Chancellor, WBUAFS, Kolkata and was graced by other dignitaries such as Dr. R. K. Malik, Joint Director (Research), NDRI, Karnal, Dr. A. K. Bandopadhyay, Ex-VC & IDA, Chairman, East Zone, representative from NABARD, Kolkata, Prof. A. K. Chakravarty, Vice Chancellor, B.C.K.V., Mohanpur, Dr. T. K. Maity, Dean, Faculty of Dairy Science, Mohanpur. Around 350 participants were present in the workshop. Issues related to status, movement and experience on milk processing industry in West Bengal as well as quality control measures in milk processing as well as detection of adulterants in milk and milk products were discussed at

large. On this occasion, a Souvenir and other 9 publications were released. The eminent dairy entrepreneurs of West Bengal were present in this workshop to share their views and experience. An interaction among farmers, dairy entrepreneurs and experts was organized. The session was chaired by Dr. R. K. Malik, Joint Director (Research), NDRI, Karnal and Co-chaired by Dr. T. K. Dutta, Head, ERS, NDRI, Kalyani. In this session, the major emphasis was given on milk processing at household level and role of co-operatives in dairy farming. Dr. Amrito Chattopadhyay, NABARD discussed on details of schemes available from NABARD for dairy farmers and small scale dairy entrepreneurs. The five progressive farmers in the field of dairying in this region were felicitated with mementoes and certificates for their exemplary achievements.



Publications of ERS, Kalyani being released

Health and Vaccination Camps at Ayodhya Pahar, Purulia

One health camp cum vaccination camp was organized in the Bhuigara, Ajodhya Hills of Purulia district of West Bengal on 16th October, 2015 under TSP. Different dairy production management systems were demonstrated to the livestock farmers. Some fodder seeds (maize and cowpea) and rooted slips of some fodder grass, mineral mixture was also distributed to the farmers who rear livestock (cow, goat, poultry, pig and sheep). A total of 141 farmers were benefitted by the camp and 1753 animals were vaccinated and dewormed.

TRAINING PROGRAMMES ORGANISED

- Two training programmes on 'Improved Dairy Farming practices' were organised on 13th & 16th-23rd December, 2015, in which, 39 farmers from Nadia, North 24 Parganas and Hoogly Birbhum districts of West Bengal participated.
- One workshop cum interaction session with farmers was jointly organized by Eastern Regional Station of ICAR-National Dairy Research Institute (ERS-NDRI), Kalyani and Rathindra Krishi Vigyan Kendra (RKVK), Sriniketan on 29.12.2015 at Sriniketan in Birbhum district of West Bengal. Experts from ERS of NDRI emphasized the importance of feeding of green fodder to the dairy animals. Experts also explained the whole process of azolla cultivation and benefits of feeding azolla to the dairy animals.

FEATURE ARTICLE

Artisanal and Farmstead Cheese Making: A Potential Tool to Increase Farm Income

(Latha Sabikhi, Head Dairy Technology Division)

Conversion of milk into products that have high shelf life and good marketability are two aspects that the Indian dairy

farmer would have to consider, if he wants to earn more from his dairy farm. Cheese is valued for its easy portability, long life and good nutritive value and hence, is an excellent way to preserve milk solids. Although India is traditionally not a cheese manufacturing country, Indians have, over the years, started appreciating cheeses, many varieties of which are now available in metropolitan cities of the country. Several companies are currently manufacturing and marketing varieties of cheeses in India.

Indian consumers have started to demand food products that have been made in a hygienic way, from natural ingredients and with minimum additives. They tend to believe that food sold at farmer markets is more safe, nutritious and less expensive. This creates a huge opportunity for converting farm produce into value added products at the farm itself. It is in this realm of activities that artisanal or farmstead cheese finds a niche for itself.

Cheese making principles state that whatever the means of manufacture, cheese is a product formed by coagulation of milk by an enzyme such as rennet in the presence of lactic acid produced by added or naturally occurring micro-organisms, followed by removal of part of the moisture by processing steps that include cutting, warming, and/or pressing. The ensuing curd is shaped in mould and ripened by holding for some time at suitable temperature and humidity. These principles are applied in several European countries and some areas of the USA to make cheese in the traditional way, in small quantities and by hand. In these countries, niche and premium markets exist for these traditional home-produced cheeses.

Artisanal and farmstead cheese form a part of speciality dairy products and are made on farm in small batches using high quality ingredients. American Cheese Society has defined artisanal and farmstead cheeses. Artisanal cheese is the cheese made by hand on a small scale, normally using milk from animals in a closed herd, and utilizing traditional and time honoured practices and using as little mechanization as possible. Farmstead cheese must be made with milk from the farmer's own herd on the farm where the animals are raised. Milk used in the production of farmstead cheeses may not be obtained from any outside source. All farmstead products are artisanal, but not all artisanal products may be farmstead.

Several Swiss varieties of cheeses are still made and marketed in Switzerland and eastern France as artisanal cheeses. Family farms in Italy make several varieties of cheeses on their farms, the most popular ones being Ragusano, Provolone, Pecorino, Ricotta and Montasio. Artisan cheese makers can be found in large clusters in several states of the USA, including Vermont, California and Washington. In Vermont, the artisan cheese makers have united under the banner of Vermont Cheese Council to promote the sale of cheese. Unfortunately, no direct data is available on artisan cheese production and sales volumes across the world.

Commodity cheeses are made in a factory, with the purpose of producing a cheese with lowest variation in taste or texture from one batch to the next. These include Cheddar, Mozzarella and Swiss cheeses that are produced in large quantities. Artisanal cheeses, on the other hand, are characterised by unique qualities including milk of other species (sheep or goat milk for instance), special processing (handcrafted, traditional techniques, on-farm production), design, limited product supply, uncommon application, and/or extraordinary packaging or sale channel. Any particular category would have a unique flavour and quality which varies from batch to batch.

They are produced in much smaller quantities than commodity cheeses and demand a premium price from consumers. There are no complicated milk pipe lines to deliver the milk in case of farmstead artisanal cheese preparation and they are almost always made on the farm using equipment and implements that are commonly available in a kitchen. However, safety concerns such as raw milk quality, clean milk production, hygiene at farm and animal health are the on-farm-dependent factors which decide the final quality of farmstead cheese. Unhygienic practices at farm level may lead to contamination that can result spoilage of the products as well disease outbreaks.

Farmstead artisanal cheese can function as markers of 'geographical indication' (GI), which deals with place-based names given to agricultural products that convey their geographical origin as well as the cultural and historical identity. Some examples of cheeses are Roquefort, Cheddar, Champagne, Swiss etc. The GI certification on a product reiterates that a given quality, reputation or other characteristic of such products is essentially attributable to its geographical origin and in case where such goods are manufactured goods, one of the activities of either the production or processing or preparation of the goods concerned takes place in such territory, region or locality. In recent times, developing countries have increasingly begun focusing on GIs as a tool to boost rural development and protect local products and traditions. The Geographical Indications of Goods (Registration and Protection) Act, 1999, has been effective in India since 15th September, 2003. Artisanal cheeses made in a certain locality and using methods or ingredients that are specific to that locality can also claim for certification under the GI act. Farmstead cheeses have a long tradition, especially in Mediterranean areas to protect the cheeses as a part of their ethnic heritage. On similar lines, we can also attempt to make and market cheese(s) that are indicative of our region.

India has no history of artisanal cheese making, with paneer being the closest that India has, in the name of cheese. Bandal or Bandel, is a smoked cheese, which originated in a Portuguese colony of the same name located in eastern India. The production is concentrated in the Bengali villages of Tarakeshwar and Bishnupur near Kolkata. Though this cheese is classified as artisanal cheese, it does not conform to the standard definition of cheese made from 'enzyme-coagulated' milk. Surti cheese is another such product from the Western part of the country, which had a traditional image to it.

Globally, farming families are involved in artisanal cheese making, the practice being deeply rooted in tradition. Many of them are made entirely of raw milk with no starter addition. Fermentation is by natural flora of the milk and the container, which, many a times is made of wood. No cheese knives are used and the curd is cut either by a kitchen knife or mixed/broken by a wooden ladle that resembles a wooden dahi churner that is common in an Indian kitchen.

The curds are almost always cooked by addition of hot water, scooped out along with whey into meshed plastic baskets to facilitate natural whey drainage. The curd may or may not be pressed down lightly with fingers to accommodate more curd in the basket. The salting is done mostly by brining or rubbing dry salt on the curd mass.

The advantages of artisanal cheese making from the Indian perspective are several. The classic cheese making steps can be adapted to the Indian system, using implements and equipment that are normally available in a kitchen. Artisan cheeses are the most successful speciality dairy products in foreign countries and its market is growing faster now, as many retailers feature local cheeses. The reason for the success of the speciality cheese sector is the opportunity for value addition associated with cheese and also lack of competition from the mainstream commodity sector, particularly in India. There being an increasing trend in the specialty food markets in India because of the consumers' readiness to buy high quality foods, cheese fits in very well as a potential candidate under this umbrella. Making artisan cheese is a way to diversify and augment farm level income.

A blueprint for Indian artisanal cheese making is already in place at our Institute. Results of the research carried out in the laboratories of the Dairy Technology Division to make cheese using the simplest of equipment and implements are highly encouraging. Conventional equipment made of stainless steel was used to hold and warm the milk. The ubiquitous dahi served well as a starter culture. The curd so formed was cut with a kitchen knife and cooked, by the addition of hot water. Plastic wire mesh baskets served as a tool for moisture expulsion. Addition of salt is best done by brining and dry salting. Such cheeses may be eaten fresh or kept in the refrigerator for a month before consumption. The technology can be adopted by small scale producers and farmers' companies, particularly those that have small quantities of milk for conversion to products. Use of simple kitchen equipment and tools make the technology simple enough to be adopted by farm women. The packaging as well as storage modes are also easily available and affordable.

With consumers turning to foods with labels such as 'organic', 'natural', 'farm-produced' and 'local food', these farmstead cheeses can establish a tradition, a brand or a name, under which the product will be sold at a premium. It can also promote research on cheese from milk of minor species such as goats and sheep, which is produced in small quantities in selected and scattered clusters in the country. There exist, several challenges too. Considering that cheese is still a rare commodity, extra efforts will be needed to create a good market for cheese in India. Awareness and familiarity of the consumers about product quality, its seasonality, availability, taste, consistency and high product cost are a few challenges that the artisanal cheese industry will have to address.

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