

NDRI News

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From the Director's Pen



Zoonotic diseases, which are transmitted directly or indirectly between animals and humans, are of great importance to dairy industry. Food-borne zoonotic diseases resulting from consumption of foods contaminated with micro-organisms such as bacteria and their toxins, viruses and parasites are an important cause of morbidity and mortality worldwide. Food-borne illnesses are a matter of great concern across the globe, since the incidence of these diseases has been increasing over the period. A WHO report estimated that food borne and waterborne diarrhoeal diseases kill about 2.2 million people worldwide annually. Other estimates vary from 76 million cases of food borne disease annually in the United States, 5.4 million in Australia to 1.3 million in England and Wales. Given the situation that in the developed EU countries, over 3,20,000 human cases of food-borne diseases are reported each year, one can visualize the incidence of the food borne diseases in India and other developing countries.

Food-borne diseases are due to contamination by different pathogenic organisms at some part of the food chain, between farm and fork. Foods that are most frequently associated with food-borne illness include milk, meat, fish and poultry. The majority of food-borne illnesses are caused by harmful bacteria and viruses. Major bacteria causing food-borne illnesses include *Salmonella*, *Campylobacter jejuni*, *Shigella*, *Escherichia coli*, *Listeria monocytogenes*, *Vibrio*, and *Clostridium botulinum*. Viral food-borne zoonosis includes, but not limited to, Hepatitis A, Norovirus, Rotavirus and Viral gastroenteritis. Major parasites involved in food-borne diseases include Amebiasis, Ascariasis, Cryptosporidiosis, Cyclosporiasis, Cysticercosis, Diphyllbothriasis, Giardiasis, Toxoplasmosis and Trichinellosis.

Out of 1406 infectious diseases that affect human beings, approximately 58% (817) are zoonotic in nature and out of 177 infections that are emerging or re-emerging about 73% (130) are zoonoses. It has been estimated that, in the least developed countries, 20% of human sickness and death was due to diseases, which have jumped from animals to humans. Changing patterns of food consumption had the major influence in the increasing incidence of food-borne disease. In a study, it was reported that in addition to isolated cases every day, everywhere during last 30 years, at least 37 major outbreaks of food-borne illness have occurred in India. Although the common forms of food-borne diseases are due to bacterial contamination of foods, high numbers of deaths have also been observed due to chemical contaminants in foods. Among the food-borne illness due to infectious origin, *Salmonella* spp, *Clostridium perfringens*, *Yersinia enterocolitica* and *Escherichia coli* were found to be the major causative



organisms in India. Increased environmental survival of pathogens, changes in prevalence of pathogens in animal reservoirs and changes in host-parasite ecology due to changing climate have enhanced the risk of food contamination and food-borne disease in human beings.

Although the losses due to food-borne disease in India have not been quantified precisely, in USA, the total economic loss from food-borne illness has been reported to be in the range of US\$5.6 billion to US\$9.4 billion. In Australia, the loss due to food-borne illness has been estimated to the tune of \$487 - \$1900 million and in New Zealand the loss is around NZ\$100 million. Here, it is noteworthy that in early 2008, the outbreak of avian influenza in Bangalore led to import ban of Indian poultry products in the Middle East, leading to loss of hundreds of thousands of US Dollars to the Indian economy.

The first and foremost important step in evolving strategies to control food-borne disease would be estimation of currently existing burden. As such we need to have a mechanism in place for conducting epidemiological survey for mortality and morbidity in food-borne diseases, developing the models for the estimation of the burden and effective reporting the losses associated with food-borne diseases in the country. In order to develop effective prevention and control strategies, it will also be necessary to understand the multiple interactions of the pathogens with their environments during transmission along the food chain. Further, constant dialogue between public health, veterinary and food safety experts is essential to signal new threats and to ensure the priority of food hygiene during production and processing.

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



Dr. Arvind R. Kaushal Secretary ICAR and Additional Secretary DARE delivering Convocation Address at NDRI on 14th February 2014.

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RESEARCH

Improved Butter Melter

(Aswin Warriar and I. K. Sawhney)

Butter is usually kept in cold storage at -18°C to -20°C in 20 or 25 kg blocks. It is melted in a butter melter before being further processed for reconstitution or into production of ghee. The study was undertaken to improve the butter melter currently used in the dairy processing plants. The improved system was designed by solving heat transfer equations using Matlab programming. The fabricated model (scale down ratio 4:1) consisted of a network of heated pipes with longitudinal plate fins. Dimensions of the tubes of the network and their spacing were kept at par with the original equipment. The variable parameters consisted of fins (with/without), heating medium (hot water/steam) and weight applied (0, 8, 16 kg). The performance evaluation aspects of the equipment, viz., butter block cutting time, cutting capacity, heat utilization efficiency, percentage molten butter, volumetric reduction ratio, U-value, average temperature gradient and free fatty acid content were studied. The results obtained from the proposed study have been analyzed through mixed factorial design. It was observed



Prototype of improved design of butter melter

that the network with fins is advantageous over network without fins, steam is advantageous over hot water and that an applied weight of 16 kg was significantly advantageous. The combination of a network with fins, having steam as the heating medium and an applied weight of 16 kg was found optimum by Design Expert Software. This combination was found to improve the capacity by three times.

Strip based Detection Tests for Adulterants in Milk

(Rajan Sharma, Y.S. Rajput, Bimlesh Mann, Panchal Bhaveshkumar R, Brajesh Kumar Rahul Thakur and Prerna Narula)

Separate strips for detection of neutralizers, urea, glucose and hydrogen peroxide in milk have been developed and validated. For detection of neutralizers and urea in milk, the test involves dipping the strip in milk samples followed by visualization of colour of the strip. The colour of the strip changes to deep red in milk containing neutralizers (immediately) and urea (after 2 min) while in pure milk samples, the strip retained its dark yellow colour in neutralizer test or light red in urea test. For detection of glucose and hydrogen peroxide in milk, the test involves putting a drop of milk on the strip followed by visualization of change in colour of the strip. The colour changes to deep pink immediately in case of adulterated milk containing hydrogen peroxide while response time is 2-3 min in case of milk containing glucose. In case of negative samples, only light pink colour appears. The sensitivity of these strip have been ascertained and is 0.04% for neutralizer, 0.06% for added

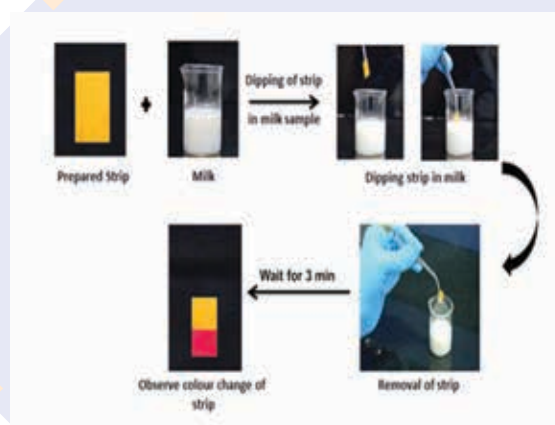


Figure: Steps in the detection of added urea in milk using strip

urea, 0.03% for glucose and 0.02% for hydrogen peroxide. The tests are rapid and results are available within 5 min.

EXTENSION

DAIRY EXTENSION DIVISION

Dairy Education at Farmers' Door

Dairy Extension Division organized the Extension Education Programme "Dairy Education at Farmers' Door" to facilitate the dissemination of dairy production and processing technologies at the village level. Under this programme a team of NDRI scientists including subject matter specialists from production, processing and management group visited Khrijpur and Wazidpur villages of Karnal.

The farmers were educated about the balance feeding of animals with special attention during the period of achieving peak yield.

Field/Farm Technician (FFT) Activity

Following extension work was carried out in the adopted villages around Karnal.

Sl. No.	Activities Conducted	Nos. of Cases
1	A.I. in Cows	372
2	Conception rate	37.40%
3	A.I. in buffaloes	215
4	Conception rate	32.00%
5	No. of Cross- breed calves born	131
6	No. of buffalo calves born	59
7	General Treatment	144

During the period, a total of 12 Veterinary camps were organized and 299 cases were treated for various reproductive disorders, ecto & endo parasites and other Veterinary ailments.. Special attention was given to improve the productive & reproductive performance of dairy animals

Kisan Sangosthies/Training Programmes

Twelve Kisan sangosthies and three training programmes for 90 participants were organized at village level on following topics

1. Control of ecto-parasite infestation
2. Role of mineral mixture in animal diet
3. Care and management of calving animals
4. Heat symptoms and correct time of insemination of dairy animals
5. Clean milk production practices in rural areas

Empowerment of Women and Mainstreaming of Gender Issues

Nine women empowerment training and campaigns were organized in villages with the objective to create awareness in the field of dairying and home science.

Educational Visits and Tours

A total of 1200 visitors (students & faculty) of 28 colleges/Institutions/Universities visited the Institute. The groups were sensitized about the different research, teaching and extension achievements and facilities available in the Institute.

Resource Poor Farmers Meet

A kisan sangosthi & animal health camp was organized in village Taraori especially for resource poor farmers. During the interactions, the farmers were educated on control measures of mastitis, checking of service period in dairy animals, ecto and endo-parasitic control and balance feeding of dairy animals. During the animal health camps, diseased animals were checked and treatment was given to concerned animals.

KRISHI VIGYAN KENDRA

Training Programmes Organized

In all 52 training programmes (On-campus and off-campus & training-cum-visits) on different aspects of dairy production and

processing, crop & vegetable production, vermi-culture, bee-keeping and home science were organized in which 1413 farmers, women, rural youth and extension functionaries were imparted training.

Sponsored Training Programmes

Out of the total courses, KVK organized 13 sponsored training programmes on scientific dairy farming, clean milk production, commercial dairy farming, milk processing and vermi-compost preparation for 346 farmers, rural youth and extension functionaries. In these training programmes 47 practicing farmers from Bihar, 27 trainees from Jharkhand, 65 trainees from Himachal Pradesh, 29 from Haryana, 30 trainees from Rajasthan, 40 trainees from Gujarat, 94 trainees from Uttar Pradesh and 14 trainees from Assam were imparted training.

Exposure Study Visits Organized

KVK also organized 21 exposure cum study visits for 598 progressive farmers and farm women from different districts of Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Bihar, Rajasthan, Haryana and Himachal Pradesh states.

Animal Health Management Activities

Various Animal Health Management activities were organized through Stockman centers in adopted villages of KVK. At these centers, 337 cattle and 313 buffaloes were artificially inseminated and 488 calves were born. Besides these, 28 animals were treated, 27 calves dehorned and 28 animals were given infertility treatment.

Revenue Generation in KVK

During the period under report, KVK and DTC generated revenue of Rs.15,10,177 (Rs. fifteen lakhs ten thousand one hundred seventy seven) through its various activities like organization of training programmes and exposure visits and sale of produce from various demonstration units.

TECHNOLOGY TRANSFER

- The technology of the test entitled "New colour based test for rapid detection of detergent in milk" was transferred to Rajasthan Co-operative Dairy Federation (RCDF) Ltd. a registered society having its office at "SARAS SANKUL, J.L.N Marg, Jaipur-302 017, Rajasthan. The MOU between NDRI and RCDF was signed on March 19, 2014.
- Technology for preparation of anionic mineral mixture was sold to Shakti Livestock Feed Pvt. Ltd, D-61, Udyogpuram, Industrial area, Partapur, Meerut 250103(UP)



Transfer of MOU between NDRI and RCDF: Sh. Pritam Singh - MD, RCDF and Principal Secretary, Dairy Development, Govt. of Rajasthan representing RCDF and Dr. G.R. Patil, Joint Director (Acad) representing NDRI



EVENTS

Twelfth Convocation of National Dairy Research Institute (Deemed University) Organized

Shri Arvind Kaushal (IAS) Secretary, ICAR & Additional Secretary, DARE delivered the 'Convocation Address' on 14th February, 2014 at NDRI, Karnal. He said that there will be many challenges before the country in ensuring the food security. He appreciated NDRI for its great contribution in livestock rearing and producing technologies for milk handling in the most profitable way, because of which dairying is expected to grow at the rate of 4-5% annually. In the past 2 decades, milk production in India has doubled, thus, becoming the top farming commodity. He said that the Indian agriculture is viewed as a model by international community because of the collective efforts of farmers. However, he showed some of his concern regarding the deficiency of feeds and fodders, good livestock germplasm, quality assurance of milk products, share of Indian dairy products in world market (less than 1%). While fully appreciating the efforts of faculty of NDRI in teaching and research, he congratulated all the recipients of degrees, medals and merits certificates.



Shri Arvind Kaushal (IAS) Secretary, ICAR & Additional Secretary, DARE giving away degrees to the passing out graduates

During convocation, 39 B.Tech., 130 Masters and 59 Ph.D. scholars were awarded the degrees. For overall contribution in research and teaching by the faculty, Dairy Microbiology Division was adjudged as Best Division, where Dr RK Malik, Head received the award from Chief Guest. On this occasion, Chief Guest also presented the best teacher awards for PG & UG teaching. Dr. A. K. Srivastava, Director & Vice Chancellor, NDRI presented the progress report on the significant achievements made by the Institute in the past couple of years.

Dr. K. M. L. Pathak, Deputy Director General (Animal Sciences) presented 'Gold Medals for Best Thesis Research Work' in the Production, Processing and Management Group. Dr. K D Kokate, DDG (Agri. Extension and Dr Suresh Honappagol, Animal Husbandry Commissioner, Govt of India presented the 'Merit Certificates' and "Appreciation Certificate(s)" to Doctoral and Master's students and complimented them.

Dr. D. Sundaresan Oration

NDRI conferred the "Dr. D. Sundaresan Oration Award" on Dr. S. Ayyappan, Secretary, DARE and Director-General, ICAR New Delhi on 11th February, 2014. Dr Ayyappan also inaugurated the state-of-the-art facility of "Climate Resilient Livestock Research Centre", one of its kind in the country. He also inaugurated the facilities at 'Livestock Research Centre' and office of 'National

Academy of Dairy Sciences (India)', besides visiting different labs of Microbiology including the under construction National Referral Lab for milk quality and safety. While speaking on the theme of 'Youth for Transforming Indian Agriculture', Dr Ayyappan said that role of youth in agriculture is vital and their capacities would matter a lot for enhancing agricultural productivity to meet the objective of nutritional security for the growing human population as envisaged under National Food Security Act 2013. In this regard, the human resource development, particularly young professionals must ensure: (a) effective communication of science in agriculture, (b) integration of social media in agriculture, (c) promotion of agriculture as a career path, and (d) a networking to influence national agenda. The '**Young Professionals' Platform for Agricultural Research for Development (YPARD)**' has been working for many years to help promote and stimulate youth participation in agriculture. This platform provides information to youth on opportunities in agricultural development, sharing success stories of young role models in agriculture and advocating for greater youth engagement and representation. Some areas of intervention include tackling policy, attracting youth to agriculture and education. He underlined the need for making youth the part of dialogues focusing on agricultural policies. There is also a need to look into new policies that best reflect the current economic, social and political climate.



Dr Ayyappan further said that the youth is an excellent source of ideas and innovations with significant impact on public opinion, policy and action. In addition, the agricultural sector, national economy and the region will also benefit as a consequence of the increased participation of youth. Addressing a large group of students and faculty of NDRI and ICAR Institutions, Dr Ayyappan

motivated youth to always practice “**knowledge-skills-Attitude-Innovation-Confidence**” as success mantra. Investing in young people on improved access to training, capacity development and facilitating access to appropriate technology with broader platform and above all bringing in innovations on day-today basis, is key to enhancing agricultural productivity, food security and boosting rural economies. Knowing this fully, the Indian Council of Agricultural Research has some useful programs in the 12th Plan period viz., Student **READY (Rural Entrepreneurship Awareness Development Yojana)**, **ARYA (Attracting and Retaining Youth in Agriculture)** and **Farmer FIRST (Farm Innovation, Resources in Science and Technology)** programs that would help motivate and involve youth in productive agriculture for a better tomorrow.

Dr. K. K. Iya Memorial Oration

Dr. S. K. Bandyopadhyay, an eminent scientist and Member of Agricultural Scientists Recruitment Board, delivered “Dr. K. K. Iya Memorial Oration” on ‘Useful Science Versus Science for Justifying Existence – A Key Issue for Performance Evaluation’. He said that apart from carrying out research, NDRI has a great responsibility of preparing future leaders in dairy sciences.



Dr. Bandyopadhyay said that we all face a great dilemma in the value judgments of science based on certain key performance indicators. He outlined these indicators as the publications, patents, technology development & commercialization, social utility of research and implementable policy. He called for the scientists and scholars to go for quality research and publication of its outcome well in time, so as to improve the ranking and standard of research institutions. In addition, he attributed the failure of technology transfer mostly due to the lack of consultations with stake-holders, economic & practical utility of technology, and the overall impact of the technology in society. Dr. A. K. Srivastava, Director, NDRI presided over the function, presented a citation to Dr. Bandyopadhyay. He also informed that Dr. Bandyopadhyay played a key role in the eradication of ‘Rinderpest’ disease of cattle and buffalo from India. Besides this, in capacity of Animal Husbandry Commissioner, he also significantly contributed in controlling the deadly bird flu in the eastern part of the country.

Dr. N. N. Dastur Oration

NDRI conferred “Dr. N. N. Dastur Oration Award” on Dr V. M. Katoch, Director General, Indian Council of Medical Research, on 10th February, 2014 as a part of celebration of Academic Month for 12th convocation. The function was presided over by Dr. A. K. Srivastava, Director and Vice Chancellor, NDRI Deemed University. Dr V. M. Katoch lauded the contributions of NDRI and its success by moving up the ladder year by year. He said that the Institute has made a mark not only in dairy science, but also in biological sciences.



Dr Katoch emphasized that there is a need for scientists at ICMR and ICAR to work in synergy mode on joint projects to address some common issues such as ‘use of pesticides’, ‘zoonosis’, and ‘food quality & safety standards’. He further said that we are not lacking in technology generation but in purposeful action for the benefit of the masses. He showed concern over the apathy of the scientists on the issues that affect public health. The agricultural scientists, medical professionals and animal husbandry professionals should work together and need to generate and collect evidence regarding these pertinent issues affecting health of the people and help create a healthy and safe environment. We also need to keep in mind our Indian ethos and Indian food habits while coping up with the nutritional transitions. Keeping aside individualistic approach, he underlined the need for sharing a common dream and common vision for the welfare and health of society.

Dairy Mela

A three day mega event of ‘National Dairy Mela’ was organized at NDRI, Karnal from February 25 to 27, 2014. Dr. K. D. Kokate Deputy Director General (Agricultural Extension), ICAR was the Chief Guest during the inaugural function and Dr. B. S. Dhillon, Vice-Chancellor, Punjab Agricultural University, Ludhiana was the Chief Guest during the Valedictory Function of dairy mela.

Around twenty thousand visitors including progressive dairy farmers, farm women and dairy entrepreneurs from different states of the country participated in Mela. During this mega event, the latest agricultural technologies developed at national level were showcased for farmers and dairy entrepreneurs. On this occasion, a number of publications prepared by NDRI including a ‘Dairy Calendar’ were also released.



While sharing his views with farmers and other entrepreneurs, Dr. A. K. Srivastava, Director, NDRI also informed that NDRI is going to start ‘Farmer’s School’ in villages for teaching farmers on different

aspect of agriculture production. In high milk producing category, Sh. Baldev, Ghalibkhaeri, Karnal got first prize for HF cross breed for yielding 50.99 kg milk. The Murrah buffalo of Sh. Ramesh, Ghasu, Hisar got first prize producing high milk (21.49 kg). The first prize for local breed of cow was given to Rashtriya Goushala, Gurana, Hisar. In other category, Rajbala of Gogharipur, Karnal got first prize for milking competition and in Paneer judging competition, Ms. Bimala, w/o Rohataash, Palnagar, Karnal got first prize.

National Science Day – 2014

National Dairy Research Institute (NDRI) celebrated the National Science Day– 2014 on 28th February 2014 with the theme **"Fostering Scientific Temper"**. The concept of scientific temper was articulated first by Pandit Jawaharlal Nehru in 1946 in his book *Discovery of India*, referring to it as "a way of life, a process of thinking, a method of acting and associating with our fellowmen". To identify and nurture the talents of the students in different aspects, a series of competitions including Essay writing, Quiz, Extempore, Debate and Photography were organized. About 70 students participated in these events and shared their views and ideas for fostering scientific temper among the students, academicians and researchers. Dr. A. K. Srivastava, the Director and Vice-Chancellor of NDRI (Deemed University), distributed certificates and mementos to the winners and runners of different events. Dr. A. K. Srivastava informed that the very purpose of celebrating National Science Day is to create enthusiasm among the people and to popularize Science and Technology to strengthen their scientific temper. He emphasized on the science/technology driven mode of food production to meet the demand for food in future.

Brainstorming Session on Potential of Animal System in Enhancement of Conjugated Linoleic Acid

A Brainstorming Session "Potential of Animal System in Enhancement of Conjugated Linoleic acid" was organised at NDRI, Karnal on 18th January 2014 and was sponsored by DBT, New Delhi. Prof Paul Ross, Director Food Research Institute, Moorpark, Ireland, who validated the anti-cancerous properties of CLA in rat and mice models; presented his talk on 'rumen to human', and elucidated that *Bifidobacterium breve* is excellent producer of cis-9, trans-11 CLA in monogastrics but some lactobacilli can also produce it. Prof Veerle Fievez from Ghent University, Belgium stated that milk can be enriched with high CLA content through stearoyl-CoA desaturase. National professor Dr. D. N. Kamra from IVRI, Izatnagar emphasised on making the feeding strategies to stimulate the pre-existing ruminal microflora, which are responsible for CLA production through plants secondary metabolites. Dr. A. K. Tyagi, convenor of the session presented the research done at NDRI and reported that CLA can be enhanced in milk, milk products and meat by different feeding strategies. Dr. Mangat Ram Garg, GM, NDDB, Anand reported that CLA feeding in dairy animals improves the fertility. The session came to an end with the conclusion that plant secondary metabolite or chemicals, which stimulate CLA production in animal systems, have to be screened and further research work is required to establish the clinical relevance of CLA isomers in human context.

Brainstorming Session on Micronutrient Initiative: A Silent Solution to Hidden Hunger

Brainstorming session on "Micronutrient Initiative: A silent solution to hidden hunger" was organized on 24th January 2014 at NDRI, Karnal. Prof. A. K. Srivastava, Director, NDRI flagged the issue of fortification and expressed that at present, food as well as nutritional security is our prime motto and concern. He expressed

concern over the fact that more than 70% Indian population consume less than 50% of the RDA of micronutrient. Dr. (Mrs) Purvi Mehta, Head South Asia Region, ILRI, New Delhi, chief guest elaborated that for micro-nutrition security in India, there is a need for multiple partners, multiple approaches and a collective voice. Himanshu Gupta, Corporate Regulatory Advocacy manager, Nestle India Limited, advocated clear regulations facilitating fortification. Ms Ruchika Sachdeva, GAIN, New Delhi stressed the need for research to support and improve the quality of fortification programs and also their implementation and delivery mechanism. Hitesh Gahane, Market Development Manager-Human Nutrition & Health – Dairy & Infant Foods – South Asia DSM Nutritional Product, discussed about different products available with DSM for milk fortification. Maj. Gen. R K Marwaha (Retd.), Consultant & Scientific Advisor ILSI, India (former Addl Director, INMAS, DRDO, Delhi explained that milk fortified with vitamin D to children is an effective and safe method of addressing the major public health issue of vitamin deficiency. Dr. Prabhakar Kanade, Chief R&D Officer, Mother Dairy, New Delhi opined that Vitamin fortification is not just another mixing process but is a proper process development, which requires a proper methodology. Dr. Sumit Arora, Principal Scientist, Dairy Chemistry Division, NDRI reported that milk and milk products and even biscuits have been fortified with Vitamins A, D, calcium and iron at NDRI. Studies related to processing stability and bioavailability has been conducted for these nutrients.

NDRI Industry Meet

The scientists at NDRI, Karnal have developed a number of technologies that have relevance in milk quality, milk safety, health foods, fortified milk products, dairy equipments, mineral mixtures etc. These technologies were presented before officials from industries in NDRI – Industry Meet organized on 6th January, 2014. The industries has shown interest in technologies of detergent detection tests, strip test for neutralizers, strip test for urea, antibiotic detection in milk, whey-mango beverage, whey jaljeera mix, bajralassi, butter melter, ghee making machine, feed blocks and mineral mixtures. The live demonstration of detergent test and strip test for detection of neutralizers and urea in milk were given to impress upon the simplicity in adaption of test by dairy industry. The industrial participation was from Rajasthan Co-operative Dairy Federation Ltd, Jaipur; Delhi Milk Scheme, Delhi; Hetauda Dairy Industries (P) Ltd. Nepal; Kamdhenu Hitkari Manch, Bilaspur, Himachal Pradesh; MART, Noida; Green Agri Miles Pvt Ltd, New Delhi and Sachdeva Milk Dairy, Sangrur.



Development of e-Courses for B.Tech. (Dairy Technology) Degree Programme

Under the NAIP Component-1 sub-project "Development of e-Courses for B. Tech. (Dairy Technology) degree programme" a

one-day Review Workshop was organized on January 08, 2014 at NDRI, Karnal. The Workshop focused on the review of the progress of project and further steps that need to be taken in future for implementation of e-Courses teaching in all Dairy Science colleges across the nation. Twelve Dairy Science Institutions participated in this workshop. Deans of various Dairy Science Institutions presented their ideas regarding the Implementation, refinement and up-gradation of these e-Courses and gave valuable suggestions for improvement. Dr. G R K Murthy, Senior Scientist, NAARM Hyderabad also contributed towards the use of Moodle and its application in e-Course management for students as well as teachers.

Short Training on Analysis of Milk, Milk Products and Cattle Feed

On a request from Directorate of Dairy Development, Kerala, a short course on "Analysis of milk, milk products and cattle feed" was organized from 10th-17th January, 2014. The training consisted of 10 lectures and was mainly focused on the practical aspects. During the training, the trainees were allowed to handle the HPLC & GLC. They were also given the hands-on experience on the use of latest techniques like biosensor based methods in testing of antibiotics in dairy products. Trainees were also familiarized with the latest methodologies being used to analyze the cattle feed.

Entrepreneur Development Programme on Milk and Milk Products

Entrepreneur Development Programme on "Milk and Milk products" was conducted by SINED TBI and BPD units of NDRI during 20-25th March, 2014. In this programme, 26 participants were selected on the basis of the pre-mentioned eligibility criteria. Participants belonged to 13 different states of the country including Haryana, Punjab, Uttar Pradesh, Madhya Pradesh, Himachal Pradesh, Bihar, Jharkhand, Delhi, Gujarat,

Karnataka, Maharashtra, Rajasthan and West Bengal. These participants comprised a diverse group i.e. from different academic and economic backgrounds. In brief, this training programme covered different aspects of milk and milk products processing which included: Processing of market milk, flavoured milk manufacture, technology of fermented milk processing, cheese making, khoa based sweets, acid and heat coagulated milk products, ice cream and frozen desserts, fat rich dairy products, whey utilization, value addition of milk at producers level, by-products utilization, chemical and microbial quality analysis of milk and milk products, detection of adulterants and preservatives in milk and milk products, brief details about FSSAI, propagation and maintenance of starter culture, utility management at dairy plant, cleaning and sanitation of dairy process equipment, packaging of dairy products.

Fodder Museum

The fodder museum has been made functional to make the students, visitors and dairy farmers aware about different types of fodder available for dairy animals. This museum includes all varieties of different perennial and seasonal fodder crops and trees. The available varieties of perennial grasses are Napier Grass –(10), Nandi grass –(5) Anjan grass –(2) and Dhaman grass –(1), which were collected from different parts of the Country.

Manual on Establishment and Administration Released

"Establishment and Administration Manual" was released at ICAR Director Conference held on 20th January 2014. The efforts made by Sh. J. K. Kewalramani, Joint Director (Admn.), Sh. J. Ravi, Director, Personnel ICAR and Ms. Roja Sethumadhvan, Deputy Secretary, ICAR in bringing out the manual were appreciated.

HONOURS/AWARDS

- **Dr. Y. S. Rajput**, Head, Animal Biochemistry Division received "**Sukumar Basu Memorial Award**" for biennium 2011-12 on the occasion of 52nd Convocation of Indian Agricultural Research Institute, New Delhi on 21st February, 2014.
- **Dr. K. P. Ramesha** Principal Scientist, SRS, Bangalore was awarded "**Best Zoologist Award**" in the year 2014 by Society for Applied Biotechnology at AABS/SAB Sponsored 'International Conference on Biodiversity, Bioresources and Biotechnology' held at Mysore.
- **Dr. Mukund A. Kataktalware** received the "**Best Oral Presentation- I Prize**" for research paper entitled "Bull Housing Management Practices under Commercial Semen Production System" on 29th January 2014 during the National Seminar on "New Dimensional Approaches for Livestock Productivity and Profitability Enhancement under Era of Climate Change" conducted by College of Veterinary Science & Animal Husbandry, Anand Agricultural University, Anand during 28th-30th January, 2014.
- **Dr. S. K. Kanawajia**, Principal Scientist, Dairy Technology Division, was awarded with "**Best Teacher Award**" (Undergraduate) for the year 2013-14 at 12th Convocation held on 14th February, 2014
- **Dr. A. Kumaresan**, Senior Scientist, Animal Reproduction was awarded with "**Best Teacher Award**" (Postgraduate) for the year 2013-14 at 12th Convocation held on 14th February, 2014.
- **Dr. Rajan Sharma**, Sr. Scientist and **Dr. P. Narender Raju**, Scientist got Certificate of Appreciation in recognition of Outstanding Contributions as a teacher at NDRI for the year 2013-14 at 12th Convocation held on 14th February, 2014.
- **Dr. Y. S. Rajput**, Head ABC; **Dr. R. C. Upadhyay**, Head DCP; **Dr. R. S. Manik**, **Dr. S. K. Singla**, **Dr. M. S. Chauhan**, **Dr. T. K. Datta**, **Dr. Darshan Lal**, **Dr. S. K. Kanawajia**, Principal Scientists, NDRI; **Dr. S. Kulkarni**, Head SRS Bangalore and **Dr. T. K. Datta**, Head ERS Kalyani were awarded the "**Fellowships of National Academy of Dairy Science, India**" in February 2014.
- **Ms. Sari TP** got "**Best M. Tech Thesis Award**" in the processing group on dissertation work "Evaluation of Physico-chemical and Biological Characteristics of Micro/Nanoemulsions Encapsulating Curcumin" during 12th Convocation of the NDRI deemed university held on 14th Feb. 2014.
- **Ms. Smita Singh**, doctoral student in Animal Biochemistry Division, joined as Assistant Professor in the discipline of Biochemistry (Basic Science and Humanities) at Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Banaskantha (Gujarat).

PERSONALIA

Joining

Dr. Bimlesh Kumari, Principal Scientist joined as Head, Dairy Chemistry at NDRI, Karnal w.e.f. 27.12.2013.

Promotions

The following Sr. Scientists were promoted as Principal Scientists:

- Dr. Shipla Viz, Sr. Scientist (Biotechnology) w.e.f. 01.01.2011.
- Dr. Rajan Sharma, Sr. Scientist (Dairy Chemistry) w.e.f. 12.04.2012.
- Dr. Vivek Sharma, Sr. Scientist (Dairy Chemistry) w.e.f. 12.04.2012.
- Dr. Rajesh Kumar, Sr. Scientist (Dairy Chemistry) w.e.f. 23.04.2012.
- Dr. Madan Lal Kamboj, Sr. Scientist (Livestock Production Management) w.e.f. 01.09.2012.
- Dr. Chand Ram, Sr. Scientist (Dairy Microbiology) w.e.f. 11.07.2013.

The following scientists were promoted to the next higher grade under Career Advancement Scheme:

- Dr. Rishikanta Singh, Scientist (DESM)
- Dr. Manoj Kumar Singh, Scientist (ABTC)
- Dr. Sudarshan Kumar, Scientist (ABTC)
- Dr. Senthil Kumar, R. Scientist (D. Extension)
- Dr. Kaushik Khamrui, Sr. Scientist (DT)
- Dr. A. Kumaresan, Sr. Scientist (Animal Reproduction)
- Sh. Ramesh Chand, Assistant Chief Technical Officer (F/FT) promoted as Chief Technical Officer (F/FT) w.e.f. 01.01.2013.
- Dr. S. Jeyakumar, Senior Scientist, in the PB-4 Rs.37400-67400+ RGP of Rs.9000/- with effect from 16.08.2012.
- Dr. Manjunath, Scientist, in the PB-III Rs.15600-39000 + RGP of Rs.7000/- with effect from 10.02.2013.
- Dr. M. A. Kataktalware, Scientist, promoted to the post to the Senior Scientist in the PB-III Rs.15600-39000+ RGP of Rs.8000/- with effect from 26.02.2013.
- Dr. P. Heartwin Amaladhas, Senior Scientist, in the PB-4 Rs.37400-67400+ RGP of Rs.9000/- with effect from 02.09.2013.

Retirements

- Dr. B. R. Yadav, Head (Library) retired from Council's service w.e.f. 31.03.2014.

- Sh. Rajpal Sharma, Technical Officer T-5 (F/FT) ATIC retired from Council's service w.e.f. 31.01.2014.
- Sh. N. S. Sirohi, Chief Technical Officer T-9 (F/FT) Dairy Extension retired from Council's service w.e.f. 31.01.2014.
- Sh. Bhagwat Singh, Technical Officer T-5 (W/S) ERS, Kalyani retired from Council's service w.e.f. 28.02.2014.
- Sh. Sarwar, Assistant Chief Technical Officer T-7/8 (L/T) retired from Council's service w.e.f. 31.3.2014.

VISITS ABROAD

- **Dr. A. K. Srivastava**, Director, NDRI, Karnal was invited to deliver a lecture on "Dairying in India: The white Gold for Nutritional Security" at University of Hong Kong, on 17th February, 2014 at School of Biological Sciences, the University of Hong Kong.
- **Dr. A. K. Srivastava**, Director, NDRI, Karnal was invited to speak at the Riddit Institutes' Agrifood Summit in Wellington, New Zealand and to visit the Riddit Institute in Palmerston North and discuss collaborative research programme during 19th – 21st February, 2014.
- **Dr. Mohan Mandal**, Senior Scientist, ERS, Kalyani attended the workshop on Reproductive Biotechnologies for Agricultural Research" at SARDI, Australia from 11th -14th February, 2014.

DISTINGUISHED VISITORS

- IAS Officer Trainees (2013 batch), IAS, UPSC, winter study tour attached with NDRI, Karnal on 7th - 8th January, 2014.
- Twelve member student delegation from USA on 16th January, 2014.
- Dr. Gregory Harper from CSIRO, Australia on 30th January, 2014.
- H E. Lyonpo Yeshey Dorji, Minister for Agriculture and Forest, Royal Government of Bhutan (RGOB) on 3rd February, 2014.
- Dr. Rodrigo Martins Alves de Mendonca and Dr. Mario Gracia, Universidade Federal de Minas Gerais, Brazil on 10th February, 2014.
- Twelve member delegation from NARC, Nepal on 13th February, 2014.
- Iwama San and Mr. Vipin Biala-Officials from Yakult Danone India Pvt. Ltd. on 18th March, 2014.
- Newly appointed faculty members, Lala Lajpat Rai University of Veterinary and Animal Sciences on 29th March, 2014

SOUTHERN CAMPUS, BANGALORE

RESEARCH

'NAGGI': A Wonder Cow of Malnad Gidda Cattle in Western Ghats Region of Karnataka - A Case Study

(K. P. Ramesha, S. Jeyakumar and Mukund A. Kataktalware)

The Malnad Gidda cattle are small sized cattle of Western Ghats region, native to heavy rainfall Malnad and coastal areas and distributed predominantly in Shimoga, Chikamagalur, Uttara Kannada, Dakshina Kannada and Udupi districts of Karnataka.

They play a unique role in the farming systems by providing milk,

manure and draft power. They give birth annually and thrive mostly on open grazing with moderate milk yield ranging between 1 and 6 lit per day.

Phenotypic characteristics and farming system of Malnad Gidda were collected among the farmers and during survey; the team encountered a Malnad Gidda cow belonging to Shri. Subba Rao, Anegolli (Age 60 years) of Maradavalli village, Sagar Taluk of Shimoga district. He rears four adult and three young calves of Malnad Gidda cattle and obtains 4 to 5 lit of milk per day for his house hold use. The family rears Malnad Gidda cattle since many



Farmer with his Naggi-Malnad gidda cow

generations and he is involved in cattle rearing for the last 40 years. During data collection, it was noted that the Malnad Gidda cow named '**NAGGI**', is now 24 years old and gave birth to 20 calves successively without any interruption/delay between calving. The dedicated farmer recorded date of birth of cow and all calving date every year and it was cross checked by the survey team. It was reported by the farmer that, the cow was born on 1989 and gave her first calf on 13-07-1993. Since then the cow gave birth annually and regularly without encountering any reproductive problem/disorder so far. The calving interval (mean $\pm$ SE) was observed to be 361.21 $\pm$ 12.04 days (12.04 months). In the present case study, it was interesting to observe that the Malnad Gidda cow *Naggi* produced 20 calves. It is evident that the reproductive efficiency of the Malnad Gidda cattle is high under farmers' field condition. There is a potential area for research to understand their reproductive pattern, behavior and performance for maximum utilization to augment their productivity.

A Profile Study of Smallholder Dairy Production Systems in Southern Region

(M. C. A. Devi, P. K. Dixit and S. Subash)

The profile study on small holder dairy production systems in the southern region was taken up with specific objectives to study the profile of small holder dairy production systems in the selected areas of southern region, to analyse selected case studies of successful small dairy farmers of the region and to study the constraints of smallholder dairy production systems in the southern region. The study was conducted in all the four states of southern region in the selected districts of Chittoor in Andhra Pradesh., Kolar in Karnataka, Thrissur in Kerala and Salem in Tamil Nadu. The data collection was done by personal interview technique with selected respondents with the help of the structured interview schedule. The socio-personal and socio-economic profile of small dairy holders revealed that majority of the respondents were middle-aged (54-68%), gender category of men (54-73%) and 27-43% women, 62-78% of primary & secondary level of education, with a occupational profile of farming and dairying (76-90%), with 10-20 years of farming experience (62-70%) with marginal farm holding of less than one hectare (56-76%). Majority of the respondents possessed 2-5 dairy animals (64-76%). The mass media exposure revealed that 65-67% of the respondents viewed farm telecast and print media utilization ranged from 24-71%. The local milk vendors played an important role in milk collection in

the region. The milk procurement price ranged from Rs.18-30/litre in the region while the milk sale price ranged from Rs.30-35/litre. The cost of milk production in the region ranged from Rs.17-23/ litre and feeding cost accounting for 60-70% of the total cost. The conception of dairy animals in the region was mostly in second insemination (40-50%) and the dairy housing profile revealed that majority of the households had 'Kutchra' type of housing (70-75%) which had mud/stone flooring with thatched roof and 25-30% of 'Pucca' housing with stone/coarse cement flooring & tiled or sheet roof. Majority of green fodder feeding comprised of weed/waste grass collected from the agriculture fields/ waste grass and limited of cultivated or purchased green fodder of hybrid napier and fodder maize/sorghum. The average milk yield per animal /per day in the region ranged from 6.0-8.5 kg/day. The milk production in the selected households was up to 10 litres/day in majority of the households in Andhra Pradesh (64%) and Karnataka (60%) which was 11-20 litres/day in Kerala (71%) and Tamil Nadu (68%). The annual income from dairying was up to Rs.50,000 in majority of the households in Andhra Pradesh which was between Rs.50,000 to 1,00,000 in most of the households in Karnataka (72%), Kerala (60%) and Tamil Nadu (61%).

Case study analysis was done from two successful small selected dairy households in the study area, which traced the history of dairying as experienced by the selected respondents, the influential and motivating factors for the success in dairying, constraints and impediments faced by the respondents and the needed support from the government and research & development organisations for facilitating them in dairying as expressed by the respondents. It was inferred from the study that dairying is a promising avenue of income-generation and livelihood support particularly for small dairy farmers.

The constraint analysis revealed that the major constraints in dairy farming in the region primarily enveloped acute water shortage, non-remunerative milk procurement price, high cost of cattle feed, non-availability of green & dry fodder, low productivity of dairy animals, non-availability of farm labour, etc. This indeed warrants suitable technological and governmental intervention for alleviating the problem and providing a fillip to dairy development in the region.

Extension Activities

- During the period under report, 192 visitors in six batches comprising of students from various educational institutes from various parts of southern region, farmers and entrepreneurs visited the institute. The visitors were taken round the institute to various sections as per their needs and were explained the ongoing activities.
- Advisory services / technical advice was rendered to the eleven needy clientele during their personal visits to the institute. The profile of advisory included availability of publications in dairy farming aspects, technical know-how and consultancy facilities for dairy business projects and training programme on dairy management aspects.

Model Training Course

The Extension Section of SRS, NDRI organized Model Training Course on "New Extension Strategies for Sustainable Dairy

Development” during 20-27 January, 2013, sponsored by Directorate of Extension, Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India, New Delhi. The training program was attended by seventeen participants. The valedictory of the training programme was presided by Dr. A. K. Srivastava, Director & Vice Chancellor, NDRI. On this occasion, the

Director released MTC Training manual, new extension literature on ‘Clean Milk Production in Tamil language’ and ready reckoner on ‘Vaccination Schedule’ in all southern regional languages prepared by the scientists of SRS, NDRI, for the benefit of farmers and other stakeholders.

EASTERN CAMPUS, KALYANI

RESEARCH

Development of Genetic Model for Improving the Selection Efficiency for Lactation Traits of Crossbred Cattle at ERS, NDRI, Kalyani, West Bengal

(Ajoy Mandal, M.K. Ghosh, R.S. Gandhi, S.K. Das, A. Santra and T.K. Dutta)

Data on 731 lactation records of 274 Jersey crossbred cattle, maintained at the Eastern Regional Station of National Dairy Research Institute, Kalyani, West Bengal, for a period of 39 years (1974-2012) were used for estimating the genetic parameters of different lactation traits of crossbred cattle using different genetic models. The lactation traits considered for this study was 305-days milk yield (MY305D), total milk yield (TMY) and lactation length (LL) of animals. The sire model, simple animal model and repeatability model were used and compared to select the most appropriate model for lactation traits. In sire model, the sires having minimum 5 progenies were considered for this analysis. The simple animal model fitted direct additive effects of animal and the pertinent fixed effects, whereas in repeatability model, the direct additive effect of animal along with the permanent environmental effect of dam was included as random effect. The effect of season of birth, year of birth and lactation number of animals were found significant and hence included in the analytical model as fixed effects. The heritabilities estimate for MY305D, TMY and LL of animals were 0.65 ± 0.14 , 0.54 ± 0.13 , and 0.25 ± 0.09 , respectively under sire model, whereas, the correspondence figures were 0.49 ± 0.04 , 0.45 ± 0.05 and 0.19 ± 0.05 , respectively under simple animal model. However, inclusion of permanent environmental effect of dam in the model (in repeatability model) improved the log likelihood value for all traits and the heritability estimates for MY305D, TMY and LL were 0.42 ± 0.05 , 0.42 ± 0.06 and 0.13 ± 0.07 , respectively under this model. The phenotypic and genetic correlations of MY305D with TMY and LL ranged from medium to moderately high (0.41 to 0.99). Similarly, the genetic and phenotypic correlations of TMY with LL were also high ($r_p = 0.69$, $r_g = 0.71$) and significant. This study revealed that heritability estimates for lactation traits of animals by sire model were biased due to ignorance of maternal effects of dam, however, in repeatability model, the heritability estimates for lactation traits were more precise as compared to estimates obtained by sire model and simple animal model. So the repeatability model, which includes direct genetic effect and permanent environmental effect due to dam, was the most appropriate genetic model for analyzing the lactation traits of crossbred cattle.

Sex Chromosome Chimerism In Twin Crossbred Calves

(Ajoy Mandal, Joydip Biswas, A. Ghosh, S. Dutta, M. Karunakaran, M. Mondal, S. K. Das and T. K. Dutta)

Sex chromosome chimerism (60, XX/XY) is a common phenomenon in multiple pregnancies in cattle in which the female

calf born co-twin with a male calf. Chimerism is characterized by presence of two cell lines with different genetic composition and can occur either artificially or naturally. Freemartin condition with serious reproductive system defects is the possible outcome of sex chromosome chimerism in heifer. Live heterosexual twin crossbred calves (one female having tag no. 2193 and one male having tag no. 2194) were born from a Jersey crossbred cow (Animal no. 1896) on 16th September, 2013 at the Eastern Regional Station of the NDRI, Kalyani, India (Fig. 1). The history of the cow was collected from the history sheet of animal maintained at this station and the veterinarian who attended the case. The animal was served by semen of 1/2 Jersey x 1/2 Red Sindhi bull in the same location for third calving. No hormonal treatment had been given to the animal. Hence, the chance of hormonal induction of super-ovulation was eliminated. The animal had a history of producing single calf in earlier two calving. The cytogenetic study of live twin calves was conducted in the karyotyping laboratory, Frozen Semen Bull Station, Haringhata Farm, West Bengal. Cytogenetic analysis of the somatic chromosomes was carried out by using the improved technique of *in-vitro* whole blood lymphocyte culture. The results of the present investigation showed that the diploid number (2n) of chromosomes of both the twins and their dam were 60 with 58 autosomes and 2 sex chromosomes. The morphology of all the autosomes were found to be acrocentric, the X and Y chromosomes being large sub-metacentric and small sub-metacentric, respectively in heterosexual twins. Chromosome constitution of the dam was normal (60, XX) whereas the heterosexual twins showed the mixture of XX or XY cells i.e. the sex chromosome chimerism consisting of 60, XX/XY. All the metaphase spread in the present study showed the presence of two cell lines characterized by different sets of sex chromosomes. Female calf showed 27% XX and 73% XY cells whereas male calf had 25% XX and 75% XY cells. The heterosexual twins examined in this study showed preponderance of male cells (XY). The similarity of chimeric sex ratio of female (XX) and male cells (XY) was found in both twin calves.



Fig 1. Jersey crossbred cow with twin calves

Health and Vaccination Camps at Bali Island and Ayodhya Pahar, Purulia under TSP

Two health camps and two vaccination camps were organized in the Bali Island of South 24 parganas of West Bengal. Dr. T. K. Dutta, Dr. C. Bhakat, Dr. S. Dutta, Mr. Alokesh Goswami attended 2 days camp on 12.03.2014-13.03.14 and Dr. S. K. Das, Dr. A. Mandal, Dr. A. Chatterjee and Dr. S. Dutta attended 2 days village camp on 24.03.2014-25.03.14 organized at Bali Island. Dr. C. Bhakat, Dr. S. Dutta, and Mr. Alokesh Goswami attended 2 days camp at Ayodhya Pahar, Purulia. Different dairy production management systems were demonstrated to the livestock farmers. Total number of 555 cows, 483 goat, 560 poultry and 47 sheep were rendered health check up and treatment during the programme at Bali Island. Total number of 459 cows, 352 goat, 73 poultry and 21 sheep were rendered health check up and treatment during the programme at Ayodhya Pahar, Purulia and total number of 250 cows, 195 goats were vaccinated during the programme at Bali Island and 152 cows, 206 goats were vaccinated during the programme at Ayodhya Pahar, Purulia.

Training programme on "Clean Milk Production" for Tribal Women Farmers under TSP

One 3 day training programme on "clean milk production" was organized at ERS, NDRI for tribal women farmers from 12th March to 14th March 2014. Twenty Santhal tribe women farmers of Nadia district participated. Dr. Sanchita Garai, Scientist & organizer of this training programme delivered a Key Note presentation on "Clean milk production" which was followed by detailed interaction with the trainees and all scientists and technical officers of this institute shared their valuable knowledge with this trainees. Dr. A. K. Srivastava, Honourable Director, NDRI, graced the valedictory function of the training programme as Chairman and distributed certificates among the tribal women.

Training Programme on "Scientific Dairy farming Practices" for Tribal Farmers

One eight day training programme on "Scientific Dairy Farming Practices" was organized at ERS, NDRI for tribal women farmers from 24th March to 31st March 2014. Twelve tribal farmers of Jalpaiguri district of North Bengal actively participated. A *Training Manual* on scientific dairy farming practices was released and distributed among the trainees. Dr. Sanchita Garai, Scientist & organizer of this training programme delivered a presentation on "Scientific Dairy Farming Practices".

Frontline Azolla Demonstrations

- Three one day training cum azolla demonstrations were organized at farmer's house on 20th January 2014, 1st February 2014 and 14th February 2014. A total of 54 farmers received the training.

FEATURE ARTICLE

Milk of Minor Species – Composition and Perceived Health Benefits

(Rajan Sharma, Y. S. Rajput, Bimlesh Mann and Sunita Meena)

Milk of ruminants is of commercial importance and among these, cow and buffalo milk occupies the major position in term of usage as these constitute 83% and 13% of total milk produced in the world. Among the minor milk species, goat milk is more popular

as it constitutes around 2.4% of total world milk production. Sheep milk and camel milk contributes 1.3% and 0.4% in total milk production of the world. According to FAO data for 2010, goat milk is mainly produced in Asia (58% of world production), in Africa (24%) and in Europe (15%), whereas sheep milk production is located in Asia (46%) and Europe (32%), and camel milk mostly in Africa (92%)(IDF, 2013). Although, basic nutrients in milk of above mentioned species are similar in nature, their content varies. Apart from the differences in content of nutrients, milk of minor species differs in many other aspects (including extent of bioactive components) compared to cow or buffalo milk. The differences in milk composition of minor species make their milk attractive to the consumers and at times are sold at premium rates.

Fat in milk is present in the form of globules and the diameter of fat globules varies from 0.1 to 20 μm . The fat globule size varies with the species and the fat globule size in camel, goat and sheep milk is smaller than the cow or buffalo milk. The mean fat globule size in camel, goat and sheep milk is approximately 2.0, 2.18 and 3.51 μm , respectively. The smaller size fat globules from the milk of minor species make the milk fat easily digestible. In a recent study done at NDRI, it has been observed that milk fat digestibility is in the order of camel > goat > cow > buffalo. Another reason for the better digestibility of goat milk as compared to cow and buffalo milk is the presence of higher proportion of short chain fatty acids such as caproic, caprylic and capric acids in goat milk. Ester linkages of short chain fatty acids are preferably attacked by lipases during digestion. The rate of creaming in raw and heated camel milk is very slow both at refrigerator and room temperature. This is largely due to smaller fat globule size and insufficient quantity of agglutinin. Levels of the metabolically valuable short and medium chain fatty acids, caproic (C6:0), caprylic (C8:0), capric (C10:0), and lauric (C12:0) are significantly higher in sheep and goat than in cow milk. These fatty acids are associated with the characteristic flavours of cheeses. Conjugated linoleic acid (CLA) content is relatively high in sheep milk vis-à-vis cow milk. However, goat milk contains lower amount of CLA compared to cow milk.

The principal proteins in sheep and goat milk are similar to cow milk. The ratio of whey protein to casein in camel milk is higher than in cow but lower than in human milk proteins. Proteins in sheep milk account for approximately 95% of total nitrogen and 5% are non-protein nitrogen (NPN). Goat milk has a higher level of NPN and less casein-N than sheep and cow milk. This is responsible for low cheese yield and weak yogurt structure and texture, while sheep milk has a very good clotting ability. Similar to cow milk, different casein fractions viz., α_s , α_s , β and κ -casein are present in the milk of goat, sheep and camel. Caprine and camel milk has lower proportion of α_s -casein which may be the reason for softer curd obtained from milk of these species. Goat milk forms a finer curd than cow milk following acidification, which mimics the condition in the stomach, suggesting it would be more readily digested. The casein micelle size is broader in distribution in camel milk (average 280 nm) when compared to cow milk. The average diameter of casein micelles for camel, goat, sheep and cow milk is 280, 260, 193 and 180 nm, respectively. The most abundant whey protein in goat and sheep milk is β -lactoglobulin. However, β -lactoglobulin is absent in camel milk and human milk. In camel milk, the highest whey protein fraction is α -lactalbumin (around 52% of whey protein) and the second highest fraction has been named as Fraction 2 (around 26% of whey protein). Among the minor proteins, camel milk has higher lactoferrin and lysozyme

content (about 2 to 3 times more) compared to cow milk. The milk of goat and sheep has lactoferrin content comparable to cow milk. Goat milk has lower IgG content compared to cow or camel milk. Camel milk has ability to inhibit gram negative and gram positive bacteria of health or spoilage significance and also exhibits bacteriostatic effect against *Escherichia coli* and *Listeria monocytogenes*.

Lactose content of goat and camel milk is lower than that of cow milk. Compared to cow milk, lactose contents in sheep milk are at about the same level, while fat and protein levels are much higher. This makes sheep milk lactose actually less in proportion to their total solids compared to cow milk total solids (22–27% versus 33–40%, respectively). The presence of nucleoside sugars in milk reflects glycosylation activity in mammary glands. Goat has a remarkably high nucleotide content of about 154 $\mu\text{mol}/100\text{ ml}$, followed by sheep (93 $\mu\text{mol}/100\text{ ml}$), and cow milk (68 $\mu\text{mol}/100\text{ ml}$). Goat milk has a unique difference in milk carbohydrate patterns compared to cow milk. Goat milk has been shown to have 5–10 times higher oligosaccharides than cow milk, which closely resembles human milk. This is of special interest to infant nutrition since these oligosaccharides have functional effects on human nutrition.

Calcium, phosphorus, magnesium, potassium and sodium are major minerals present in cow, goat, sheep and camel milk. Amongst the trace minerals, copper, iron, manganese and zinc are present in these milks in measureable amounts. However, there are some striking differences in levels of individual minerals in milk of these species e.g. calcium and phosphorus are higher in sheep milk. Similarly, camel milk is relatively rich in sodium and iron in comparison to milk from other species. Sheep milk is comparatively very rich in thiamine, riboflavin, vitamin B₆, niacin, pantothenic acid, vitamin B₁₂ and vitamin C.

Perceived health benefits of milk of minor species

Health benefits of milk of minor species have been viewed in two perspectives. Firstly, the composition of milk of minor

species has been evaluated with respect to human milk. It has been a practice in many parts of the world to use goat and camel milk as substitute of human milk in case of emergency. The absence of β -lactoglobulin (absent in human milk also) in camel milk which is the major allergen in milk of cow, buffalo, sheep and goat has attracted the attention of many. Further, the ratio of whey protein to casein in camel milk is high, which results in soft curd and therefore, digestibility is easier. As the content of αs_1 -casein (absent in human milk) is less in goat and camel milk, the curd formation is weaker and therefore, can be considered suitable milk for feeding to infants. Further, because of the lower size range of fat globules in goat and camel milk, the digestibility of fat from such milk is better. The second perspective about the health benefits of milk of minor species is the presence of bioactive components which make them attractive for their therapeutic potential. Sheep and goat milk have been recognized for the presence of high amount of oligosaccharides. Milk oligosaccharides are thought to be beneficial for infants with regard to their prebiotic and anti-infective properties. The presence of high amount of anti-microbial factors in camel milk also makes it suitable for infant nutrition. Goat milk being rich in taurine can be included in infant formula diet especially designed for premature infants who lack the enzymes needed to convert cystathionine to cysteine. Although concrete scientific evidences are lacking, camel milk is considered good for diabetic persons and also alleviates alcohol induced liver injury. Similarly, goat milk has been in demand for recovery of dengue patient. This activity might be related to presence of alkylglycerol – a minor lipid which occurs as non-esterified or esterified form with fatty acids/or phospholipids in goat milk. Alkylglycerol has been identified as a platelet - activating factor and is highly potent even at nanomolar concentrations. Studies using crude mixtures of alkylglycerols reportedly have shown several therapeutic functions, including tuberculostatic and anti-inflammatory effects. The concentration of this compound in goat milk fat is 10 times higher (1 mg/g goat milk fat vis-à-vis 0.1 mg/g cow milk fat) than cow milk fat.

Although composition of milk of minor species has been studied, the difference (or absence) in the extent of presence of individual components have not been brought out well. The perceived health benefits have not been compared with milk of major species in controlled experiments. Camel milk appears to be a suitable candidate for substitution of human milk. As camel milk is devoid of β -lactoglobulin and less proportion of αs_1 in goat and camel milk make them an interesting new raw material for infant formula and for nutrition in countries where these animals thrive.

Obituary

Dr. Sunil Kumar Sirohi, Principal Scientist Dairy Cattle Nutrition Division, NDRI Karnal passed away on 26th February 2014. Born on 9th of February (1964) in dist. Bulandshar of Uttar Pradesh, he was one of the most dedicated scientists and teachers. His milestone achievements were improvement of poor quality feeds, rumen manipulation and protein nutrition. NDRI family conveys its heartfelt condolences to the bereaved family and prays that his soul may rest in peace.



9.2.1964-26.2.2014

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