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Valorization of Indigenous Livestock and Poultry – An Approach towards their Conservation

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Indigenous livestock species have co-existed with humans as important contributors to food, income, socio-economic and cultural status for centuries. The livestock scenario in present times has changed from a resource-driven activity based on local conditions and environments to one driven by demand. Consequently, specialized traits of low-producing indigenous livestock breeds are ignored in emerging, high-input-based farming systems. This has led to a progressive replacement of traditional multipurpose breeds with high-yielding ones and more profit-oriented farming. Since indigenous livestock cannot compete in production with industrial livestock systems; it is reasonable to focus on their unique qualitative aspects as a means of conservation and source of livelihood. Fortunately, many local breeds and species have a large but often unrecognized potential to produce items that customers appreciate and demand. Many local breeds are bestowed with unique qualities like colored wool, disease resistance, patterned hides, super-fine fiber, especially palatable meat, or milk with therapeutic or health benefits. Local breeds can produce unique products that can generate significant levels of demand and can help rescue a threatened breed from further decline or extinction.

Introduction

Rearing indigenous livestock breeds in today's economy is usually less lucrative than keeping high-yielding commercial breeds. Characterization of indigenous germplasm, including their product quality traits, needs immediate attention as it could strengthen the position of local breeds in the current consumer scenario. The value of local breeds as sources of culinary delicacies is well established in parts of the developed world. In Europe, many special kinds of cheese and meats are associated with particular breeds. Products of local breeds are often processed in traditional ways. The need to conserve milk or meat without refrigeration has led to the development of unique sausages and cheese. In Germany, meat from breeds such as the Heidschnucke sheep and Schwäbisch-Hallische pig fetches a premium price in gourmet restaurants. In North America, too, there are efforts to market the meat and wool from heritage breeds. In these countries, the marketing of cheeses, sausages, wool, and other specialty products has contributed to the conservation of indigenous breeds, enhanced regional identities, and stimulated rural economies. In developing countries, however, examples of this approach are rare.

It is imperative to identify and document traditional livestock, their products, and their processing methods. The genetic valuation of these breeds is also warranted so that biomarkers related to specific traits can be used for breed improvement and viable conservation. Further, analysis of the special properties of the products in terms of sensory qualities, nutritional value, and medicinal effects need to be evaluated. Such an approach will result in:

- Inventory of existing traditional products and processing methods from the selected breeds
- This can further lead to better understanding of the technological requirements for producing products tailored to urban consumer preferences
- Awareness among communities. policy makers and private enterprise regarding economic opportunities inherent in local breeds
- Insights into the potential and promise as well as criteria for a special label/brand for products

The idea behind creating niche markets is to raise the value of local products and support sustainable, regional, small-scale production systems. Realizing the opportune time to break new ground, the science and technology ministry (DST) of India has initiated funding research projects that seek to pinpoint bioactive ingredients in dung, milk, and urine of "pure indigenous cows" for use in medicinal, nutritional, agricultural and household products. The program is titled "Scientific utilization

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through research augmentation-Prime products from indigenous cows (Sutra-Pic). Recent scientific efforts in underpinning the quality attributes of the Indian livestock that can be exploited for augmenting their value and promoting sustainable utilization are compiled below:

Potential Dairy and Meat Producing Indian Livestock and Poultry

Superior Milk of Indigenous Cow

Consumer perception of Indian or desi cow milk is associated with the assumption that it differs from the milk of taurine cattle and their crossbreds. Numerous studies from different parts of the world have compared the milk composition of their indigenous and universally used breeds including their crossbreds. There is a dearth of knowledge in this regard from Asia including India. Milk of indigenous cattle maintained only on grazing had a more favorable nutrient profile than the cows maintained under an intensive system of management (Sharma *et al*., 2018; 2018a). The saturated fatty acids (SFA) proportion was lower (61.40%) mainly due to the medium-chain FA group (15.1%). The milk was enriched in total n-3 fatty acids and total unsaturated fatty acids (UFA, 38.6%) including MUFA (31.4%) and PUFA (7.2%). The n-6/n-3 ratio (2.7) and Atherogenic index (33.9) were significantly lower in grazing milk. Concentrations of minerals (Zn, Fe, P, Cu) and all the vitamins except vitamin B5 were significantly higher ($P<0.05$) than in the cattle under intensive management. Vitamin A, C, E, and β-carotene were more than double. Being antioxidants, these are nutritionally desirable to reduce oxidative stress. Moreover, the yellow tint of cheese and butter caused by carotenoids of milk fat is an attractive attribute for consumers. It is considered to be an indicator that the product has originated from cows thriving on pasture diets. Higher milk productivity was never the reason why Indian zebu cows (*Bos indicus*) were revered in India as it is the quality of milk that has been the talk of folklore. It is possible, that almost total pasture feeding in ancient times was responsible for the proclaimed health-promoting qualities of the milk. Organic milk production with particular emphasis on grazing is gaining momentum throughout the world which suggests a promising future for indigenous cows maintained on grazing.

Bhadawari Buffalo – Milk with the Highest fat Content

Bhadawari breed is famous for the high-fat content in their milk. Bhadawari buffaloes are found in the ravines of Yamuna, Chambal, and Utangan rivers spread over Uttar Pradesh and Madhya Pradesh. Though the total lactation yield is lower, fat content in the milk has been recorded as high as 13%. The average milk yield of the breed is 1294 Kg per lactation with an average fat % of 7.88 (Yield ranging between 540-1400 Kg per lactation and fat % from 6 to 12.8).

Chilika Buffalo – Curd with a Longer Shelf Life

Chilika buffalo are unique as they are found only around Chilika Lake, in the Khordha, Puri, and Ganjam districts of Odisha, and feed on seaweed in neck-deep, brackish waters of Chilika Lake. Perhaps because of the high salt content in the animal's diet, the milk is not only very tasty but can also be stored without refrigeration for days. Both the milk and other products such as curd made from milk are attracting attention. It is widely observed and reported that Chilika curd has a longer shelf life and has been scientifically established. A total of 64 microbial isolates were isolated from curd and milk samples collected from Chilika (Nanda *et al*., 2013). Surprisingly, 8 Lactobacillus isolates out of the above were found to show anti-fungal effects against the test organism *Candida parapsilosis* (NCDC 279), which can be correlated with the preservation of curd from fungal spoilage and enhancing its shelf life. Such isolates can be used as a starter for making curd with better shelf life. Products with extended shelf life can be beneficial for a country like India where major population reside in villages that can't afford refrigeration facilities and there is no need for a cold chain during transportation.

Buffalo Milk as a Source of Bio-defensive Milk Peptides

Buffaloes are considered more resistant to diseases than cattle (Pal and Chakravarty, 2020), although, little scientific evidence supports this assumption. However, a study was conducted to compare the transcriptomic profiles of milk somatic cells of Sahiwal cattle and Murrah buffaloes (Ahlawat *et al*., 2021). A noticeable enrichment of innate and adaptive immune response genes and various host defense peptides such as lysozyme, defensin β and granzymes was reported in buffaloes. The expression of LYZ1 (lysozyme C) was observed to be seven times higher in buffalo milk in comparison to cattle. Lysozyme is a bacteriolytic enzyme found in body fluids such as tears, saliva, and milk and therefore forms an important component of mucosal immunity in

mammals (Masschalck *et al*., 2001). β defensin is known to function as a natural antibiotic (Meade and O'Farrelly, 2019) and granzymes are released by CD8 T cells and natural killer (NK) cells that trigger programmed cell death of infected or abnormal target cells. Based on these observations, buffalo milk can be exploited in the future for various bio-defensive milk peptides and hence, offers novel paradigms for the development of effective and novel therapies.

Goat Milk – Therapeutic Potential

The vitamin and mineral contents of goat and cow milk are fairly similar, though goat's milk contains more calcium, vitamin B6, vitamin A, potassium, niacin, copper, and the antioxidant selenium. Goat milk contains 25% more vitamin B6, 47% more vitamin A and 13% more calcium than cow's milk. Goat milk is an excellent source of calcium, phosphorus, and potassium. It is also a good source of magnesium, sodium, and iron. Goat milk offers a wide variety of health benefits such as better digestibility, more alkalinity, less αs1 casein than cow's milk and is, therefore, less allergenic. It is also useful in the treatment of ulcers due to its more effective acid buffering capacity. Unlike cow milk, which is slightly acidic, goat milk is alkaline, which is very useful for people with acidity problems. It is more digestible because of its smallsized globules, uniform protein, fat distribution, and less lactose.

Kadaknath Chicken Black Meat – Better Functional Attributes

The autochthonous Kadaknath is the only black meat chicken breed among the 19 chicken breeds registered in India (https://nbagr.icar.gov.in/en/home/). It is the only indigenous animal genetic resource in India to get the Geographical Indication (GI) tag for the protein-rich and black-colored meat in 2018 (https://ipindia.gov.in/writereaddata/Portal/IPOJournal/1_2598_1/Journal_104.pdf). The tribal community of Bhil and Bhilala are the primary custodians of this unique backyard poultry. The peculiarity of this breed is that the entire bird and its internal organs are black due to the deposition of melanin pigment, a genetic condition called "Fibromelanosis" and is supposed to have aphrodisiac and medicinal properties. But, there is a paucity of literature that can endorse the claims of nutritional and medicinal properties of Kadaknath meat. A recent study reported that the Kadaknath meat is an enriched source of functional biomolecules (carnosine, anserine, creatine). Its breast meat carnosine content was more than double of the Cobb broiler (Sharma *et al*., 2022). The genetic background may be a key determinant as a significant abundance of CARNS1 and SLC36A1 expression was identified in the Kadaknath breast. The superior functional property of Kadaknath meat was established by the antioxidant capacity (Sehrawat *et al*., 2021) and a stronger ability to inhibit the formation of advanced glycation end products (AGEs). The identification of fairly unknown nutritional and functional advantages of Kadaknath meat could potentially change the paradigm with its meat consumption. It will help in developing a brand name for Kadaknath products that will propel an increase in its market share and ultimately conservation of this unique but endangered poultry germplasm.

Barbari Goat Meat – A Blend of Taste and Nutrition

Meat from livestock is an ideal source of protein and nutrients such as iodine, vitamin B12, zinc, and iron. Goat meat has less fat and cholesterol as well as lower saturated fatty acids content than chicken, lamb, beef, and pork (Ivanovic *et al*., 2016), which will provide an edge in marketing as a health food for cardiovascular diseases. Barbari is a dual-purpose breed used for both meat and milk and is considered the best meat breed (Paramasivam *et al*., 2002; Mandal *et al*., 2016). Among Indian goat breeds, lower cholesterol levels have been reported in Barbari muscles (Das and Rajkumar, 2010). Therefore goat meat or chevon from such breeds as Barbari presents a healthier option as compared to chevon from other breeds. Chevon from Barbari goat is considered of good quality and this breed is preferred for commercial goat farming (Das and Rajkumar, 2010; Umaraw *et al*., 2017). Functional genomics analysis of Barbari muscles has also identified significant genes and pathways associated with triacylglycerol biosynthesis and lipid metabolism (Kumar *et al*., 2021), which lends support to the better organoleptic properties of its meat.

Bandur Sheep Mutton – A Prized Delicacy

Mutton from the Bandur sheep breed of Karnataka is favored by consumers for its unique flavor and fetches a higher price than other local breeds. Research revealed a higher back fat thickness in Bandur animals as compared to local sheep. Tenderness of different muscles (longissimus dorsi, brachicephalicus, bicep, semimembranosus, psoas major, semitendinosus, and tricep) was also greater in Bandur sheep. The amino acid and fatty acid analysis revealed a significantly higher

level of oleic acid and histidine in Bandur (Kumar *et al*., 2018; Arora *et al*., 2019). Higher content of oleic acid has been positively correlated with overall palatability while histidine is an essential amino acid required in the diet. The discovery of higher fat content, tenderness of muscles, oleic acid and histidine will add value to the mutton from Bandur sheep. Genes associated with muscle tenderness viz., HSPB1, DNAJB5, HSPA6, were also overexpressed in Bandur sheep. The highly connected genes identified by transcriptomics (CNOT2, CNOT6, HSPB1, HSPA6, MAP3K14, and PPARD) and miRNA form potential biomarkers for unique muscle traits of Bandur sheep (Kaur *et al*., 2020; 2020a; Arora *et al*., 2021). The phenotypic and genetic evaluation of mutton quality characteristics of Bandur sheep has presented the scientific basis of superior quality/taste of Bandur sheep mutton that will augment sustainable conservation of this breed and its recognition as a Geographical Indicator.

Potential Value of Wool and Fibre from Indian Breeds

Changthangi Goat – The Source of Soft Gold (Pashmina Fibre)

Pashmina is well known for its fineness, warmth and softness. It is luxurious, softer and warmer than superfine merino wool. The word pashmina originated from the word 'pashm' which means 'soft gold' in the local language. The fiber is mostly used for preparing shawls with designs by the artisans of Jammu and Kashmir and Himachal. In India, two pashmina-producing goat breeds are found i.e. Changthangi and Chegu. Changthangi breed is domesticated in the Ladakh region of Jammu and Kashmir and Chegu in Lahul and Spiti and Kinnaur region of Himachal Pradesh. The physic-mechanical assessment of pashmina fibre has revealed optimal values of resiliency and compression for fine wool, thereby affirming the superiority of Pashmina in terms of softness and fullness, over other wool fibres (Bumla *et al*., 2012). Recent studies based on skin transcriptome have delineated the genes and pathways relevant to Pashmina production (Ahlawat *et al*., 2020; Bhat *et al*., 2021). Comparison of the skin transcriptome of Changthangi with meat-type goat identified a higher expression of genes associated with fine fibre in Changthangi goat. Among all shades, the white Pashmina fetches the highest price. The evaluation of differentially expressed genes in black, white, and brown skin samples of Changthangi goats revealed enrichment of ASIP gene in white skin in comparison to brown and black skin samples (Bhat *et al*., 2019). There have been meager systemic/scientific approaches for qualitative and quantitative improvement in Pashmina production and productivity. The pashmina production system is mostly open range type and depends on pastures.

Magra Sheep – Lustrous Wool

Magra sheep, formerly known as the Bikaneri breed is an important breed of Rajasthan. Magra sheep have been identified to be suitable for the desert tracts as the breed can sustain if watered only twice a week without any adverse effects on body weight. This unique breed is the only lustrous carpet-wool-producing breed in India (Dass *et al*., 2003). This breed can be used to improve other wool-type Indian sheep (Mehta *et al*., 2004)

Prospective Value of Non-conventional Livestock Species and their Products

Equid Milk

Milk from nontraditional animal species (donkey, camel) is recently gaining momentum mainly because they are considered suitable to supplement the needs of special population groups (i.e., infants, elderly). Research on their milk has dramatically increased over the past few years to decipher their unique functional properties, namely, antimicrobial activity, immunomodulation, and hypoallergenicity, especially highlighting their effect on human health and the potential utilization of medicinal, nutritious and cosmetic properties.

Donkey Products

The donkey (*Equus asinus*) is one of the most valuable domestic animals for the economy in many developing countries. Donkey meat is a healthy food with high protein but low fat and cholesterol contents while donkey milk composition is similar to human milk and more suitable for infants compared with those of other mammals. It is drunk fresh or in powdered form. It is considered a good alternative for consumers with dairy allergies such as cow's milk protein allergy. The low allergenicity is mainly attributed to the low casein content, which is very close to that in the human milk. In particular αs1- and β-caseins in different phosphorylated forms are present. The sale of donkey's milk is practiced now as villagers of Karnataka and Tamil Nadu sell donkey milk at a high price in Bengaluru. India has lost more than half of its donkeys with a massive reduction of >60% in its population since 2012. ICAR-National Research Centre

on Equines (NRCE) has been entrusted with the job to explore possibilities of promoting donkey milk in the country that can lead to their conservation.

Camel Milk

The dromedary camel is an important component of the dry land and desert ecosystem. It is not only an important means of transport but also serves as a source of milk for camel-rearing societies. Camel milk is considered white gold and a powerhouse of good health for its rich nutrients and immunity-building properties. It is reputed to be anti-infectious, anti-cancerous, and anti-diabetic. Covid-19 has put greater focus on immunity boosters and increased interest in camel milk products due to its high vitamin C, many minerals, and immunoglobulins. It may act as the main criterion for the sustenance of indigenous camels in the present era of diminishing draught utility. Camel milk is also used in Kazakhstan as an adjunct to chemotherapy for some forms of cancers. It is claimed to have a remedial effect for at least 13 different kinds of diseases and also to be an aphrodisiac by the Somali people. The current scientific evidence for the therapeutic actions of camel milk continues to unfold, and efforts are underway to precisely identify the therapeutic constituents. The establishment of such components in camel milk may act as the main criterion for the sustenance of indigenous camel breeds in the present era of its diminishing draught utility. Camel milk has been reported to be used for treatment of various diseases including tuberculosis. Camel milk production has become a booming trade in Middle Eastern countries. As camel milk has gained popularity globally, India is now warming up to the idea of camel milk production and consumption. Camel milk from Kutch region of Gujarat is already available in the retail shelves of major metros and cities across the country. Camel herders are more willing to keep an increasing number of animals as they benefit from the extra income gained from selling camel milk. This can help revive the continuously declining numbers of indigenous camels and the livelihoods of their herders. The claimed therapeutic actions of milk have recently been the subject of numerous studies.

Sheep Milk

Sheep milk is considered an excellent source of nourishment for humans. The amount of fat, calorie, essential vitamins and minerals are nearly twice that found in cow milk. A sufficient quantity of calcium and magnesium make it a perfect food for aged people. It also contains the highest amount of casein and whey protein when compared to milk from other ruminants. Favorable fatty acids are abundant like conjugated linoleic acid (CLA), and unsaturated fatty acid in sheep milk. As a result, sheep milk finds use in cosmetic skincare products like creams, soaps, and lotions. Indian sheep are low producers and sheep milk has never held prominence in the Indian dairy industry, while sheep breeds from Europe and the Mediterranean region are major dairy breeds. Some of the prominent dairy sheep breeds are Eastern Friesian (Germany), Lacaune (France), and Awassi (Middle East). The famous classical cheeses made from sheep milk are Roquefort, Feta, Manchego, and Pecorino. The Patanwadi sheep holds potential as a dairy breed as it is considered a higher milk yielder among Indian sheep, with an average daily milk yield of 800g and a lactation period of 90 days (Mohapatra *et al*., 2020).

Yak Churpi Cheese

Churpi is a traditional cottage cheese made from yak milk, found in different hilly regions of India including Sikkim, Darjeeling, and Ladakh. Yeast, mold, lactic acid bacteria, and Bifidobacterium sp. are the major participating microbes in Ladakhi churpi. Microbial interaction during the fermentation of milk makes it more nutritious. It is enriched in riboflavin, thiamine, and vitamin C. It also contains a very good amount of protein (60–63%) and carbohydrates (23–24%); and a low amount of fat (7–8%) (Panda *et al*., 2016). Commercialization based on exploiting the unique properties of Churpi can add commercial value to the declining indigenous yak and cattle (Siri) populations of the Himalayan region.

Future Prospective and Action Points

1. Spinning a value chain from native livestock produce is gaining momentum across the globe. The idea behind creating niche markets is to raise the value of local products and support sustainable, regional, small-scale production systems. India is bestowed with large livestock biodiversity that offers a great opportunity to produce a variety of convenient value-added livestock products as well to improve their income from the livestock sector.
2. Value can be added to products from traditional farming systems through the identification of quality

attributes. Increasing consumer demands for superior quality food and regional products point toward potential markets for such products.

3. Efforts need to be directed towards value addition to livestock by processed products. Goats, sheep, and equine milk can be processed into yogurt, cheese, skincare, or utility products. Their hair and wool can be utilized in making traditional clothes and carpets. Dung can be a source of income in the present time of upcoming organic farming. Demand for processed cow urine and ghee is also anticipated for use in traditional medicine.
4. A great scope exists in India for the processing of milk/meat to value-added products such as ready-to-eat/ready-to-cook products for the growing population with fast urbanization and change in lifestyle. Livestock farming can become more remunerative by changing the place, time, and form of its products as per the market requirement with an innovative mindset after a watchful study of consumer preferences. Farmers need to grab these prospects of enhancing their income from the identical amount of livestock that they are having.
5. State government departments can guide the farmers for skill up-gradation training conducted by them from time to time for preparation of value-added processed livestock products, in labeling and packaging of the product, and in extending market support as well as an incentive to communities for the sale of value-added material.
6. By concerted efforts, it may be possible to find a match between the qualities of the local breeds, the features of a particular product, and the demands of a specific market. Making this match will help conserve the breed as well as provide a livelihood for people involved in the value chain. This conservation strategy could establish a new place for indigenous breeds in modern agriculture.

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