CURRENT STATUS AND FUTURE STRATEGIES FOR CAMEL PRODUCTION IN INDIA

N.V. Patil¹, K.M.L. Pathak² and Champak Bhakat¹

Camel belongs to the family Camelidae in the suborder Tylopoda (pad-footed); order Artiodactyla (even-toed ungulates). The family camelidae includes two genus- *Camelus* and *Lama*. The genus *Camelus* has two species viz. *Camelus dromedarius* (single humped or dromedary) having habitat in dry hot arid lands of Africa and Asia and *Camelus bactrianus* (Double humped or Bactrian) habitat in cold and lands of Central palearctic ecozone. These two species are customarily called Old World Camels. The species belonging to genus *Lama* are *Lama vicugna* (Vicuna), *Lama guanaco* (Guanaco), *Lama llama* (Llama) and *Lama pacos* (Alpaca). These four species are termed as New World Camels having habitat in South America.

India possess two species of the family camelidae viz. *Camelus dromedarius* and *Camelus bactrianus* and ranks 7th in the world for camel population. The distribution of Indian dromedaries (one humped camel) population is mainly confined to the north-western part of the country. The states of Rajasthan (0.498 million), Haryana (0.005 million), Punjab (0.043 million) and Gujarat (0.058 million) state almost 93.12% of the population and the bactrians (double-humped camel) is 563 camels found in the cold desert of Nubra valley in Jammu and Kashmir state of India. Breed wise camel population is being reported in the national and state livestock census. The camel population in India during 2007 livestock census showed

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a decline of 18.2% from 2003 population figures. In the last one decade camel population in the arid zone shows decreasing trend of about 25 percent. The population decline is matter of great concern and it can be mainly attributed to continued shrinkage in grazing resources and increase in command area both under canal and tube well irrigation and fast urbanization pressure.

Research on camel in India is mostly concentrated at National Research Centre on Camel (NRCC), Bikaner which is established as July 5, 1984 as Project Directorate on camel and later upgraded as NRCC is mandated to undertake basic and applied research for improvement of camel, to provide leadership and co-ordinate camel research and training nationally and act as a national repository of information and to collaborate with national and international agencies for camel research and development. After achieving the initial goals of collection of base line data on various breeds, physiological, nutrition, health, reproduction and management aspects and development of basic infrastructure facilities including the modern laboratories, the Centre has advanced the research leading to the molecular characterization of the camel breeds and development of molecular tools for exploring the genes of economic importance, disease diagnosis, development of growth and production databases, standardization of the technique of embryo transfer, sonographic monitoring of the reproductive organs in camel, hormonal standards specific to camel, artificial insemination, herbal formulations for the treatment of important camel diseases, nutritional requirements for various physiological states, shelter management, amelioration of climatic stress, package of practices, characterization of camel milk proteins and development of value added camel milk products. The Centre has also been recognized as a Camel education and research hub by the Indian and foreign universities. To cater the requirement of the camel breeders of the country the selected studs are distributed to the camel breeders through the state governments for the improvement in the field. Health care and training for the extension of camel milk products are the important constituents of the extension activities. In addition the camel researches are also conducted as a part of academic requirement in the State Agricultural and Veterinary Universities on various aspects of basic camel physiology, biochemistry, anatomy, nutrition, management, health, surgery and reproduction.

In order to improve the Camel production system and live under conditions of people rearing camels in harsh arid and semi-arid

the research approach continues to be to undertake researches on exploring newer areas of the camel production through scientific conservation, management, nutritional security measures, disease control and extension methods for various production and beneficial functions of camel and exploit and utilize its unique physiological and adaptive capabilities through basic and applied researches.

The key areas addressed are – Development of human resource in camel production and health management and establish linkages with all the stakeholders of national and international stature, Development of ideal package of management practices including nutritional interventions for optimizing camel productivity in the climate change conditions, Exploiting unique Camel Immunology for human and animal benefit using biotechnology tools, Exploration and expedition of insight of camel Diseases- Diagnosis, establishing molecular basis of host pathogen relationship and its control, Assessing of Camel milk and value additions to enhance quality and utility, Development of functional foods by identifying active principles, Improvement in camel reproduction efficiency using assisted reproductive technologies, standardization of AI and protocol, Exploring camel genome for improvement in growth and production potential, Establishment of genetic repositories for conservation and improvement purposes, Assessment of draught power of camel, energy budgeting and utilization in different spheres of transportation, farm operations and power generation, Exploiting camel for its adaptation ability to various biotic and abiotic factors prevalent in the local areas of habitations and knowledge of microbial and metabolic basis using Metagenomics for the Camel's adaptability and maintenance of its function on the feed and fodders of low nutritional quality in the region.

Camel in Indian conditions

The camel is an important component of fragile desert. The camel has become an icon of adaptation, with its unique biological characteristics, to formidable ways of living in arid and regions. The proverbial *Ship of Desert* earned its epithet of its indispensability as a mode of transportation and utility in desert. However, its utilities are subject to social and economic changes. Despite mechanical transport and their function, it still contributes considerably to the area inhabited by them. It is used for transport of cash crops and similar entities from villages to adjoining

towns and cities for sale. Camels in carts also transport urban goods more economically than motorized vehicles particularly where small quantities are delivered to individual service points with relatively long halts. Camel also easily accomplishes household needs, such as transport of water and other similar needs of normal houses. Camels are used widely as plough animals and seem to be equally as efficient in producing draught as most other species. The livestock rearing as the major component of arid agriculture remains an active drought proof activity as can be visualized in the state of Rajasthan (Patil, 2006).

The camel milk is used in the camel rearing people as a source of nutrition and health and its use is very much comparable to other conventional milk.

Camel population scenario

World Camel population is estimated to be around 25.89 m spread across 47 countries. About 85% of the camel population inhabits mainly eastern and northern Africa and rest in Indian subcontinent of 7.00 million followed by Sudan 4.25 m, Ethiopia 2.40 m, Niger 1.65 m, Mauritania 1.49 million, Chad 1.39 m, Mali 1.15, Pakistan 0.95 and Kenya 0.94. India stands tenth in the world ranking with 0.51 million camels (FAOSTAT, 2011). The majority of Bactrian camels in central Asia. of dromedary type except small population of Bactrian camels in central Asia.

As per Government of India Census India rank 7th in the world for camel population and in Indian camel population is mainly confined to the north-western part of the country. The states of Rajasthan (0.49 million), Haryana (0.128 million), Punjab (0.043 million) and Gujarat (0.058 million) inhabit almost 93.12% of Indian camel population. The other states where camel occurs in the substantial numbers are Uttar Pradesh (0.036 million) and Madhya Pradesh (0.015 million). Eleven arid districts of Rajasthan contribute 78.86% to the camel population. The camel density during 1987 in India and the state of Rajasthan camel population and 55.70% to the Indian camel population. The camel density during 1987 in India and the state of Rajasthan was 0.31, 2.10, 2.90, 0.30, 0.85, 0.12 and 0.03/km², respectively. Rajasthan was 0.31, 2.10, 2.90, 0.30, 0.85, 0.12 and 0.03/km², respectively. Rajasthan was 0.31, 2.10, 2.90, 0.30, 0.85, 0.12 and 0.03/km², respectively.

Shift in Camel Population - a cause of concern in India
The density in 11 arid districts of Rajasthan was 2.72/km².
17th livestock Census 2007 overall camel population in Rajasthan was 0.51 million from 2003 population figures. Where population was by 13.6%.

last one decade camel population in the arid zone shows decreasing trend of about 25 percent which is matter of great concern and it can be mainly attributed to continued shrinkage in grazing resources and increase in command area both under canal and tube well irrigation and fast urbanization pressure.

Camel genetic resources

1. Dromedary - Single-humped camel (*Camelus dromedarius*):

Based on utility two main classes of Indian camels are distinguished - draught camel and riding camel. There are eight distinct camel breeds/strains besides several other strains developed and named after local breeding tracts. These strains are syntheses of mostly one or more of the 4 main camel breeds, viz. Bikaneri, Jaisalmeri, Kachchi and Sindhi.

2. Bactrian - Double-humped camel (*Camelus bactrianus*):

Based on Livestock Census (2007) the population of Bactrian - Double-humped camel (*Camelus bactrianus*) in India is 563 camels which are available in the Leh and Nubra Valley of Ladakh (J & K). Mostly they are wild. Detail survey and data were collected on different aspects of (hair production & quality, reproduction, nutrition, disease etc.) double humped camel. These should be further researched for future utility and conservation of this species. Immediate efforts are needed to create utility of these camels in the area and to multiply these animals for their conservation. Bactrian camels are suitable for cold desert and can prove to be very useful economically as domestic animal in this zone through agricultural and short distance transport.

Game camels - The camels are becoming very popular as game animals, particularly in the Gulf countries where very lucrative prices are paid for good racing animals. The race camels have very good remunerative price and export value. Studies so far conducted at NRCC, Bikaner have indicated that with proper research input, Indian Jaisalmeri partially young age group (3-4 yrs) female are superior as comparison to males and other breed and can be used to compete with race camels presently used in Gulf countries.

Commercial
Good export potential for race and milk camels. The has genetic potential to be developed as racing camel

Current Status and Future Strategies for Camel Breeding

The Kachchhi has very good milch potential and is one of the finest draught breeds of the world. The thoroughbred strain. The Bikaneri breed is one of the finest draught breeds of the world. The Bikaneri breed is one of the finest draught breeds of the world. The Bikaneri breed is one of the finest draught breeds of the world.

A national policy in this respect can prove to be very beneficial for the country considering the multiple utility of camel and camel by-products. India can become one of the major camel and camel by-products exporters and can contribute for future development to improve camel production systems in the country would be of technical as well as economic nature.

Conservation of Camel genetic resources: a need of hour.

Conservation of Camel Genes

In order to conserve the entire genetic diversity of camels, it is very much essential to initiate a network breeding project on a regular basis. A comprehensive conservation approach would be through selection of breeding studs, sorting out of reproductive and regular basins, ensuring proper nutrition and facilitating the health problems, ensuring proper nutrition and facilitating the marketing and related activities in Mewar region of Rajasthan, to initiate the network activities in Jammu and Kashmir for double humped parts of Jaisalmer and Bikaner districts. in Kutch district of Gujarat and also at cold arid part of Jammu and Kashmir for double humped camels through NGOs and/or State Government set up. As camels are live gene banks, the characterisation of diverse camels animals are live gene banks, the characterisation of diverse animals are live gene banks, the characterisation of diverse animals through transcriptome analysis and other molecular techniques documenting and further utilization of the genetic basis of unique camels is very much required.

Field scenario:

documenting and management - Field scenario: of the species is very much required.

Camel production Camel husbandry system is in a state of flux and is deviating from their traditional extensive management systems like almost semi-intensive and intensive feeding systems. Use of camels under such conditions. Camels are generally considered environmental friendly and are not associated with environmental degradation. Use of camels as a renewable natural resource for short distance transport, power generation and agriculture operations need be emphasized as an advantageous that will help in conservation of flora, fauna and fertility also. Development of camel-based livestock systems and help to improve income of the camel breeders and help to improve fertility also.

An understanding of traditional husbandry practices and rapid change in irrigation system and cropping pattern and continuous increase in agriculture area for fulfilling demand of human population is important before research priorities are established. Understanding socio-economic conditions of poor resourced dry land farmers is also important for deciding camel development activities.

Camel Milk products:

Camel milk is also gaining some commercial status in Gujarat and parts of Rajasthan where it is sold at the competitive price. Camels could be exploited for augmenting the country's milk production, capacity as a supplementary milk resource in India for the benefit of increasing human population. Since milk production potential of camels in India have remained untapped and considering its therapeutic utility it can fetch good price. Milk can have substantial utility in some of hilly belts and can be source of income. In addition to milk products like hair, bones, dung and hide in village cottage industry can be source of supplementary income.

its nutritive value it may differ in some of the constituents and the but it is rich in vitamin C, some of the micro minerals (copper, iron), whey proteins and free form of calcium. These properties make milk an important health promoter, an animal product of pharmaceutical values and it is expected that value added milk can be formulated in future. Commercial dairies have also not at few places. It is now felt that camel milk used for the consumption will serve as a life support system for the peoples in arid areas. As a milk animal camel is advantageous and produce milk for a longer period, especially it provides milk in dry season.

is unique in terms of having low fat (1.5-3%), low protein and low carbohydrate content, long shelf life, higher ratio of b-casein to k-casein, absence of a₂- and b-lactoglobulin and presence of Whey Acidic Phospholipid and Oligodiglyceran Recognition Protein. There are reports that camel milk has medicinal and other therapeutic properties but milestones have yet to be achieved and research efforts are needed to establish the medicinal and adjuvant role of camel milk in view of its exceptional uniqueness.

Trade in camels is an important and good source of income for the people of Rajasthan. Many livestock fairs are being held in Rajasthan for the purpose of trade in camels. Rajasthan and Gujarat support this trade of sale of camels.

purchase in arid lands. The price realized through sale/purchase trend is fluctuating depending on fodder availability and prevailing drought conditions but middlemen involved in marketing also limit the profit availability to the camel-breeding communities. The average cost of adult healthy camel now ranges from Rs. 20,000 to Rs. 40,000 depending upon age, sex and health (Bhakat and Pathak, 2009).

Evaluation studies on Integrated Rural Development Programme (IRDP) in Bikaner, Rajasthan indicated higher average income of camel and camel carts. The credit flow was substantially higher in this sector and is predicted to increase in years. Comparative economic analysis of bullock and camel power use on farms in Haryana revealed that maintenance cost of a camel but the study also indicated that higher than the cost of a camel but the study also indicated that bullocks and camels both were under-utilized. The average working days/year is less than 163.33 days. Therefore efforts should be made to utilize remaining draught power either in custom hiring service or transport or as animal bio-energy for other non-conventional uses such as grinding and chaffing. A survey on the use of camel draught power as source of livelihood and their contribution to augment net income as family conducted by the Centre revealed that average net income of the camel cart owners ranged from Rs. 2,000 to Rs. 5,000/month/cart and the maintenance cost was estimated to range from Rs. 40 to Rs. 45/day (Bhakat et al 2006) depending upon fodder availability and rates.

Research In Camel at National Research Centre on Camel: The National Research Centre on Camel (NRCC) is the premier research centre on camel not only in India, but has also gained prominence as one of the prominent research organisations in the world dedicated to the cause of camel and camel keepers. The contribution of the Centre in conducting, collating and coordinating research of the Centre has received national and international recognition and camel has received the following research and development needs mandated to fulfil the following research and applied research mandate of NRCC are (1) To undertake basic and applied research improvement of camel. (2) To provide leadership and co-ordination of camel research and training nationally and act as a National agency for camel research and development.

The National Research Centre on Camel (NRCC), Bikaner

established on 5th July 1984 On September 20, 1995, it was upgraded to National Research Centre on Camel (NRCC). The Centre has also been identified as one of the important tourist place of Bikaner. The NRCC fascinates scientists, visitors, pastoralists, farmers and society at large. NRCC has developed modern well-equipped laboratories in different disciplines, camel museum and camel milk parlour, other infrastructure such as administrative block, Library, ARIS cell.

NRCC Infrastructure:

Research Laboratories : The NRCC has modern laboratories for camel physiology, camel reproduction and biochemistry, camel breeding & genetics, camel health and camel management, camel nutrition and pathology laboratory.

Camel herd: The Centre possesses an elite herd of around 365 camels comprising of Bikaneri, Jaisalmeri, Kachchi and Mewari breeds. It also has fodder godown, feed technology unit and electronic weigh-bridges.

Camel museum: The Centre has one camel museum which offers visual documentary of cultural, ethical, social, economical and scientific aspects of camel. It possesses the specimens of various utility products made out of camel bones, hair and hide. It also contain model camel and its use, saddles and different scientific exhibits etc. There is pictorial and iconological depiction of role of camel in history and mythology.

Visitor's Room: A room for the visitor's has been developed for camel farmers and guests to gain more information about Centre's and Camel researches.

Camel milk parlour: The Centre has established a milk parlour of different value added camel milk products such as Camel milk cream, Flavored milk, lassi (fermented whey), tea and coffee served from the camel milk are available.

Agro-forestry farm & Range-land: The Centre has 689 ha land divided in five blocks with three tube wells. The land has been used under perennial silvipasture comprising of grasses, shrubs etc. The land is used for fodder cultivation and grazing of camels irrigated by tube wells.

Library: The library is well enriched with a good collection of books and reference books to keep the scientists and technical staff of the latest scientific and technical development both in India and abroad.

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Agriculture Knowledge Management Unit (AKMU): Agriculture Knowledge Management Unit is well equipped with the latest hardware and software, a broadband, LAN and Server. E-mail and internet facilities. The facility is also provided to the Indian and foreign research scholars joining the Centre for education and training.

Administrative (ADM) Building: The new administrative building has the Director's cell, reception, administrative section, central stores, committee room, official language section, library, AKMU and PME cell are located in it.

Guest House: The Centre has one guest house with six A/C and a

hostel with 3 Non AC Room, with kitchen, dining and reception.

Others: Modern facilities like conference room of 120-sitting capacity equipped with latest audio-visual facilities projector and public address system and a committee room with 40-sitting capacity and multimedia facility are available for holding scientific and conference, meetings and group discussions. A spacious community centre has also been constructed for organizing academic, cultural & other creative activities. All laboratories and other facilities are provided with uninterrupted power supply by generator set.

Future thrust of Camel Research through Harnessing Science advancements

NRCC would make efforts to reestablish the place of Camels in the arid and semiarid zone of the country by utilizing power of technological innovations for highlighting the virtues of Camel for the benefit of farming system prevalent in the region and production utility to human and animals for supporting the health and production aspects. The efforts done would consist of undertaking basic and applied researches proving its adaptation worth for the harsh situations, its production value in terms of milk and other products of human and agriculture benefit, use of gene pool for its thermostability during heat and cold situations, its novel immunity to combat biotic and abiotic stresses beside using latest technological advancements for conservation efforts, exploiting economic value characters and understanding nutritional and management requirements in the situations of harsh and unfavorable environment.

Conservation of camel genetic resources

In order to address the problem of continued dwindling population of the camel (both dromedary and Bactrian), it is essential

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different camel genetic resources available in the country be preserved by maintaining representative stocks *in vitro* and *in vivo*. To establish elite herds of different camel breeds in their respective home tracts so that improved purebred sires can be distributed for local camel breed improvement programme and also purebreds of respective breeds are to be conserved. Immediate attention for Conservation of double-humped (Bactrian) camel is needed as only few hundred animals are available in the country.

Camel Biotechnology

The power of biotechnological tools can be put to use to know unique abilities of camel and therefore can be used to undertake works like development of new generation vaccine for camel and other livestock, exploitation of single domain Antibodies from camels to develop diagnostics and therapeutics for human and animals, Functional genomics and proteomics of cells involved in the immune system of camel, Development of diagnostics and new generation vaccine against the infectious diseases of camels, Development of vaccines against the vectors infesting the camel, Generation of cell lines of camel origin and development of preventive vaccines and immuno-diagnostics against common camel diseases.

Camel production and management

The major constraints of camel rearing impinge on the socio-economic conditions of resource poor dry land farmers. Research to develop package of innovations to introduce ideal management practices, for camel calf appropriate to eco-systems and traditions applicable to region for economic and healthy upkeep of camels will be initiated. Study of traditional camel management system and its impact towards intensive and semi-intensive in light of changing grazing pattern and shrinkage of grazing resource, change in rearing patterns and its impact on social and economic status of camel-rearing societies will be studied.

Though the camels are adapted to various kind of environmental situations like, high temperature and solar radiation and camel every attempt to maintain a constant condition of entire body of the energy available, but it remains a limiting factor for growth performance. The efforts will be made to ascertain the ability of camels to a modified comfortable but practicable type of climate/ shelter and know its effect on the adaptive physiological functions and also on biological and behavioral aspects. The studies on ethological aspects of camel are necessary

because camel have to adapt changed effect of climate to maintain better health status. The feeding behavior, neonatal, parturition and rutting behavior would be required to study to formulate scientific package of practice.

The wide reaching, participatory information and communication technology would be evolved by optimizing print and electronic delivery system and by showcasing the research products in the Museum for effectively linking research accomplishments with camel rearing community.

Camel Nutrition

Camel nutrition remain an important area of attention as the rearing system is changing with loss of grazing grounds and too much restrictions on the movement of grazing animals. Research on capability of camel to survive under stress on coarse fodder under drought and scarcity conditions will be focused. The studies on development of improved nutrition management practices for high yielding dairy camels, Optimization of protein and energy utilization from different feed resources for improving productive and reproductive performance will be initiated. There is need to continue Studies on nutrient requirements for different physiological stages like growth, pregnancy and milk production and to work out feeding standards for camels by utilizing local feed resources for optimum and economical production. The fodder trees suitable for different agro-climatic condition of the country have been detailed by Patil *et al.* (1983).

The unique ability of camels to utilize feeds of poor quality need be studied by knowing the rumen kinetics, fermentation pattern with special reference to methane mitigation and isolation of rumen microbes of importance and study their morphological, biochemical, molecular characterization and enzyme profile. By the metagenomic approach the functional metabolism of the nutrients in camel rumen and GI tract in general need proper research attention. In order to develop low cost feed there is need of identification, evaluation and utilization of feed and fodder resources available locally. Detailed studies will be conducted on nutritive values of shrubs, grasses and trees available in the range-land. And with loss of grazing and integrated feeds there is need to identify newer feed resources and as complete these in the complete feeds as TMR or feed blocks or as complete feed pellets so that the feeding of camels become economical and balanced. Research is required to be done to evolve Sultani

technologies for improving the utilization of conventional and non-conventional feeds and fodders, Evaluation of toxic/anti-nutritional factors in camel feeds and fodders especially tannins, their metabolism and amelioration with respect to camel feeding and address the problem of Poor growth rate, late maturity and Poor draughtability of camels by Strategic feeding of deficient nutrient supplements, develop appropriate area specific mineral mixture and evaluate under farm and field conditions, use of Probiotics/ prebiotics for enhancing nutrient utilization, Processing poor quality animal feeds from crop residues and waste from food-processing industries. Cillaris and top feeds-Loong (P.cineraria leaves) were used in weaner kids found to provide marketable body weights at 9 months age and were found to be economical (Patil *et al.* 2006).

Camel Physiology and Biochemistry

The draft power of camel can be harnessed for agricultural operations in small holdings and in those sowed fields where agricultural tools operated by tractors cannot be used. The efforts will be made to exploit animal draft and study work physiology, draught capacity, work-rest cycle and to associate work standards with physical, physiological and biochemical parameters. Suitable selection criteria will be developed for the improvement of work capacity of camels.

To know the practical ability of camel for various purposes like taking efficiency, milk production capacity, performance in terms physiological and productive functions like growth, reproduction based on its body condition, the efforts will be made to derive the condition scores for Camels and relate it to various functions

Reproduction:

Camel reproduction has inherent peculiarities which in some way are responsible for the decreased or reverse population growth. i.e. Seasonal breeder (traditionally bred in winter- December only); Long gestation period (almost 13 months); induced in females and gelatinous semen (mainly responsible for standardized artificial insemination in this species). These are jointly responsible for longer inter-calving period.

One strive to blend ARTs and biochemistry to find effective to the above mentioned problems in order to improve the efficiency in camel at farm as well as field level. The production technologies viz., embryo transfer, embryo sperm sexing, nuclear cloning transgenic animals,

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identification of fecundity gene and their use for improving prolificacy
need be the part of genetic selection and breeding and would replace
the conventional breeding methods in near future (Mishra and Prasad,
2005).

Camel health

Health management of camel need a special attention in the light
of Calf mortality in young camel calves in the age group of below 1
year due to common but curable diseases which is one of the reasons
for reduced camel population. Camel health programme will include
epidemiological studies on camel diseases, their diagnosis, prevention
and treatment. Research on development of vaccines against camel
trypanosomiasis, camel-pox and enterotoxaemia using latest
biotechnology techniques will be priority areas. Attempts would be
made to develop immuno-diagnostic kits for some important diseases
made to develop investigations on control of skin diseases, abortions
diseases. Research investigations on problems, which need immediate
attention and surveys in the areas will be conducted to know the
prevalence and traditional practices followed by the farmers and based
on the information available the scientific validation in general
undertaken for ethno veterinary products and practices will be
and as per need the treatment and diagnosis support services will be
offered. Further research on therapeutic role of camel lactoferrin and
other protective proteins is needed.

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