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Camel Milk Technology Development in Kenya: Achievements, Lessons Learnt and Way Forward

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Abstract

For over 10 years, the Kenya Agricultural Research Institute (KARI), Marsabit Centre, together with stakeholders and community groups has been conducting research for development on camel milk technology to develop food security and value added products. This paper summarises the achievements, lessons learnt and way forward in this road of camel milk technology development. Results show that camel milk technology development has undergone various phases, i.e. research on camel milk production, composition, value addition, marketing, and technology transfer, and considerable progress has been made. Various technologies and information packages have been developed. Farmers/ beneficiaries have adapted some of the technologies to suit their local conditions. However, sustaining some of the gains made has been a major challenge. Further research should focus on the development of milk products with longer shelf life, such as camel milk powder, and establishing the best technology transfer model appropriate for pastoralists. There is also need to move from the small scale businesses to large scale enterprises which can transform lives, so as to contribute towards the country's blue-print of becoming an industrialised country by the year 2030.

Introduction

Camel milk is one of the key foods available to pastoralists in the arid and semi-arid lands (ASALs) of Kenya (Farah, 1996; Farah and Fischer, 2004). It contributes to food security and cash income through sales (Field, 2006; Anderson *et al*., 2012). However, milk is perishable and needs to be handled well to minimise spoilage and postharvest losses (Walstra *et al*., 2006). It is also important to diversify the various products that can be made from camel milk. For over 10 years, the Kenya Agricultural Research Institute (KARI), Marsabit Centre, together with stakeholders and community groups has been engaged in camel milk research and development in pastoral areas of Kenya. However, a synthesis of the progressive achievements is largely non-existent. This scarcity of progressive achievements limits the development of the camel milk sub-sector. This paper, therefore, summarises the achievements and lessons learned in the camel milk value chain in pastoral areas of northern Kenya with the objective of making the value chain contribute optimally towards increase incomes, employment creation and reduced food insecurity in these areas. The synthesis will also provide a platform for future work on camel milk technology development in Kenya.

Methodology

The paper is based on a synthesis of project reports on camel milk technology development done by KARI and stakeholders in northern Kenya. Documents reviewed included specific studies, progress reports and various journal articles.

Achievements

Camel milk technology development has undergone various phases of emphasis: camel milk production, composition, value addition, marketing, and technology transfer.

Camel milk production and composition

Initial studies on camel milk in Kenya were concerned with milk production potential, i.e. estimating the daily milk production by camels in Kenya. Milk production by the major camel breeds in Kenya is summarised in Table 1.

Table 1. Milk yield of camels in Kenya

Breed	Milk yield (L/day)
Somali	5–8
Gabbra /Rendille	3– 4
Turkana	2– 3

Source: Farah and Fischer (2004)

The milk yields reported in Table 1 may not sound very impressive when compared with dairy cattle in moderate temperate zones of industrialised countries. Considering, however, the local feed base in ASALs which is frequently inadequate, such yields indicate that the camel is a potentially better milk animal than the African Zebu cattle in the ASALs. The daily milk yield of those cattle under the same environmental conditions varies between 0.5 and 2 litres (Stiles, 1995). The annual camel milk production in Kenya is estimated at 340 million litres, valued at USD 107 million (Musinga et al., 2008), and this represents 12% of the national milk production (MoLD, 2009).

The next phase involved determination of the composition of camel milk. Table 2 summarises some published information of camel milk composition in comparison with that of other domestic animals.

Table 2. Average composition of milk from camels, goats, cattle and human

Components	Camels	Goats	Cattle	Human
	----------Expressed as percentage----------			
Moisture	86-88	87-88	86-88	87
Protein	3.0-3.9	2.9-3.7	3.2-3.8	1.63
Fat	2.9-5.4	4.0-4.5	3.7-4.4	3.75
Lactose	3.5-5.8	3.6-4.2	4.8-4.9	6.98
Ash	0.6-1.0	0.8-0.9	0.7-0.8	0.21
Energy (Kcal/100g)	70	70	66-74	72
	----------Expressed as mg/100g----------			
Calcium	116	133	128	30
Phosphorous	87.4	97	108	15
Vitamin C	2.5-6.0	1.97	1.45	4
Cholesterol	37.15			

Source: Farah and Fischer (2004); Farah (1996)

The medicinal value of camel milk has also been authenticated. Camel milk has medicinal properties for managing diabetes, autism, tuberculosis, lactose intolerance, etc (Nikkah, 2011a). With the important nutritional and health properties camel milk is increasingly being recognised globally as a functional food (Nikkah, 2011b). However, logistic challenges in manufacturing and processing must be overcome.

Value addition and marketing

The primary aims of processing milk are the production of quality and safe food for consumption, and the creation of additional income for livestock owners and milk traders (Walstra *et al*., 2006). Value addition research and development was mainly implemented between 2000 and 2011. Research approaches used were those that would enhance technology adoption and uptake at community level. The diagnostic and constraint identification phase included participatory methods, rapid rural appraisals, and detailed exploratory and diagnostic surveys. Identification, development, testing, and dissemination of technologies aimed at solving identified production constraints were carried out on site using Farming Systems Research and Participatory Learning and Action Research approaches. Some of the tools used included community-based planning workshops, feedback workshops, and participatory monitoring. Producers were included in the research planning process and invited to participate in institutional workshops and research advisory committee meetings, both at the local (KARI Marsabit) and national levels. Capacity building involved providing adult literacy classes for participating groups, technical training and demonstrations, and exposure of producers to novel concepts and practices through study tours. Participants were debriefed immediately after the tours through discussions on what had been learned and the actions they planned to take. Partnerships were formed and sustained during the camel milk technology development. The partnership was between KARI, other researchers, community based organisations, non-governmental organisations, service providers, etc.

The technologies, innovations and information packages developed in northern Kenya are summarised below:

1. Milk processing and preservation using appropriate technologies. Whereas the technologies were tried and tested at group level, they have been adapted at household level in various ways. Several products can be made from camel milk, including fermented milk, cheese, butter, ghee. Several milk bars have been established in towns and settlements in the ASALs selling camel milk and milk products (Anderson *et al*., 2012). In Kenya, so far there is one camel milk dairy in Nanyuki. The dairy is, however, operating at very low scale. According to Field (2006), the dairy has not been pro-poor and has favoured neither the producer nor the consumer (prices being neither producer nor consumer friendly), and this is one of the reasons for its pitfall performance.

2. Ghee preparation using cream separator technology. The traditional method of extracting milk fat from cow milk does not work on camels because of the structure of camel milk (Farah and Fischer, 2004). With the cream separator technology introduced, the production of ghee (clarified butter), which by the local methods for cow milk is very labour intensive, has been made much easier and can be made without destroying the skim milk component. Ghee is considered a delicacy by the pastoralists and constitutes a significant part of the diet where it is used to prepare gruels.

3. Innovations to promote marketing of hygienic camel milk. This involved promoting the use of metal cans wrapped with wet hemp to aid in cooling the milk, and in designing suitable donkey careers to facilitate milk marketing. This became popularly known as the "Milk Can Revolution". This was necessitated by the poor hygiene along the camel milk chain, and the consumer willingness to pay for good quality milk, which is an advantage to value addition initiatives targeting milk hygiene.

4. Evaporative charcoal evaporative cooler. This was necessitated by the postharvest losses occasioned by the high ambient temperatures and lack of cooling facilities in the ASALs. The technology is a small cabinet, 0.75 m^3 in capacity made of galvanised angle iron frame reinforced with wire mesh inside and out, leaving a 10 cm-wide cavity filled with charcoal. A water reservoir at the top keeps the charcoal wet through drip system. A wind driven fan on the roof enhances air movement through the wet charcoal walls by sucking out the air in the cooler, keeping the storage space temperature below ambient temperature.

5. Use of solar energy in processing of milk. Solar energy can be used to provide process heat for pasteurising milk. This was targeted to address the scarcity of energy sources for processing milk in the ASALs. The pasteuriser consists of a flat-plate water heating solar collector and a 1.5 mm stainless steel cylindrical milk vat. The milk vat has a capacity of 80 L and a 50 mm wide hot water jacket insulated with 38 mm thick fibreglass. Water in the solar collector is directly heated by the sun; the hot water produced is used for pasteurising milk. Introduction of solar energy for milk processing is supported from the position of both resource availability and demand for energy, and the need to protect the fragile environment in the ASALs.

6. The camel milk value chain has been characterised and key actors and leverage points identified. The camel milk value chain generally

involves distinct value adding activities which go into the production of the milk and its delivery to final consumers in the market. These activities include input supply; production; bulking and product assembly; cold storage; processing; transportation; and wholesale and retail trading, and service providers (Musinga *et al*., 2008).

7. Consumer perceptions on the quality and marketing of milk and determination of willingness to pay. Research from northern Kenya found that focus groups can be conducted successfully in pastoral areas to explore consumer perceptions on milk quality, as an initial inquiry for value addition initiatives. It was also established that Vickrey auctions can be used to estimate willingness-to-pay (WTP) for milk quality in pastoral areas. These WTP auctions generate non-hypothetical data on consumer valuation of milk attributes and are a first step towards identifying the potential market for quality milk. Results show that consumers are willing to pay for improved milk quality, which is an advantage to value addition initiatives targeting milk hygiene.

8. Camel milk standards: Standards for raw and pasteurised camel milk have been developed to steer camel milk technology development. These standards prescribe the specifications under which camel milk can be regarded as safe for human consumption.

Lessons learnt

Some of the lessons learnt during the camel milk technology development include the following:

1. Adaptation of known technologies to local conditions is rewarding as part of KARI's role in feeding the population of Kenya, and local communities appreciate the practical application of modern appropriate technologies which they can control on their own and turn into income generating activities.

2. Sometimes during adaptation the farmers/ beneficiaries adapted the technologies to suit their local conditions.

3. Study tours/ exchange visits are an important means of participatory technology development with resource-poor farmers. Farmers learn more from fellow farmers.

4. Field days, agricultural shows and taste fairs are an effective means of promotion of camel milk and milk products. Many organisations have been promoting camel milk in such ways but this need to be done in a more scientific way so as to gather data that can inform policy. There

have been 'pastoralist weeks' where camel milk has been one of the items promoted. This needs to be strengthened.

5. Despite the positive achievements from the developed technologies and information packages, sustaining some of the gains made has been a major challenge. Some of the introduced technologies have collapsed. It was also generally observed that pastoralists are slow in adopting technologies, and this hampered camel milk technology development efforts. The Agricultural Technology and Information Response Initiative (ATIRI) were introduced to catalyse the technology adoption process. The initiative gave farmers a chance to identify their own problems and, based on this, demand specific technologies that are developed and promoted to address their constraints. This enhanced the technology adoption process. Experiences from ATIRI showed that pastoralists are less likely to adopt labour intensive technologies; and this, therefore, needs to be considered in the development of camel milk value addition technologies.

6. Effective heating and cooling are essential to food processing and preservation processes and the related marketing of the products. The camel milk value chain offers challenges to the food technologist who desires to market high quality, safe products processed in remote ASAL areas with high temperatures and without the infrastructure for roads or electricity. Products spoil fast at high temperatures where the level of contamination is also high. Any cooking process meant for preservation is currently done by use of scanty wood fuel which has negative consequences on the environment, and consequently leads to increased climate change as a result of reduction of carbon sink. Considering the low socio-economic status of the population in the ASALs and the poor infrastructure in these areas, appropriate postharvest technologies are needed to minimise milk losses along the value chain. Besides solar energy reported in this paper, there is need for assessment of the use of other renewable energy technologies (such as wind, which is abundant in the ASALs) in milk processing.

7. The ultimate aim of value addition is to develop camel milk products with longer shelf life such as UHT and powdered camel milk which can be stored for long. Attempts so far have not been successful; UHT processing of camel milk is presently not possible as the caseins in the UHT milk decomposes after 3 weeks upon storage at room temperature. On the other hand, processing of camel milk powder requires sophisticated infrastructure such as reliable electricity and modern dairy equipment which at the moment is out of reach for pastoralists in the ASALs.

8. Development of camel milk technology should not be done in isolation but as an integral part of a whole system. The technology itself is like a 'hardware' which needs a 'software' for the system to work efficiently. The software here includes stable and functioning groups with efficient group dynamics, literacy levels to be considered and necessary infrastructure (e.g. energy, transport, water and communication) to be available. This has been the shortcomings of many projects implemented by development agents in the region, which have ended up failing.

9. New technologies and developments are opening up pastoral areas to greater movements of people, goods, and ideas. Examples include mobile phones as well as improvements in roads. Milk traders, for example, now transact business using mobile phone money transfer (e.g. M-pesa) instead of sending money using informal means which were risky (e.g. hand delivery, use of buses or taxies which are not licensed to transfer cash, etc.), whereby sometimes the money got lost. **M-pesa** is an innovative mobile phone based money transfer service introduced in Kenya in 2007, and is the most successful mobile money service in Africa (Mas and Morawczynski, 2009). M-Pesa system enables its users who do not have bank accounts to: (i) deposit and withdraw money, (ii) transfer money to other users and non-users, (iii) pay bills and (iv) purchase mobile phone credit, and transfer such credit to other users. It is highly popular in the remote areas because of its accessibility by the rural population.

10. The value chains research approach should be sustained in the camel milk technology research and development by starting from the consumer's end; supply what the consumers want.

11. Camel milk is increasingly being commercialised and consumed in urban centres in Kenya. With the increasing urbanisation and demand for camel milk and milk products due to the rising human population, value addition technologies are needed that will ensure camel milk is transported from the remote pastoral production areas to the market in the urban centres.

12. Peri-urban camel milk marketing has evolved, whereby camel keepers herd their lactating camels around towns which serve as markets for their milk. Similar milk marketing systems has been observed in Ethiopia (Hussein, 2010). Technologies on peri-urban camel husbandry need to be developed to capture the emerging marketing scenario (e.g. feeding, etc.).

13. Many organisations (private, public) are now involved in camel milk research and development in Kenya today. To avoid duplication, there should be synergies and networking. Networking and partnerships has been embraced by KARI, with the formation of the Department of Outreach and Partnerships, which among others, promotes up-scaling of adoption of value-chain based KARI technologies, products and services; promote establishment and strengthening of strategic partnerships for research development utilization continuum, etc.

14. Financing the high up-front costs of camel milk technology development is an impediment to a more widespread use of the developed technologies. The Government needs to promote policies aimed at making financial services and credit facilities more accessible to pastoralist communities, in order to provide the much-needed capital for investing in enterprises such as small-scale milk collection and processing. Financial institutions such as K-Rep and Equity Bank have already ventured into pastoralist areas to provide the much needed capital.

15. Climate change and value addition research. In view of changing climate the camel is the preferred livestock for food security in the ASALs and technology development should build on this opportunity.

Conclusions and way forward

Considerable progress has been made in the development of camel milk technology. Even though sustaining some of the gains has been a major challenge, the camel milk sub-sector is geared for take-off because of the increasing demand due to its health benefits, the growing population and urbanisation, and the consumer awareness and willingness to pay for hygienic camel milk. Camel milk technology development should, therefore, strive to ensure that camel milk is transported from the remote pastoral production areas to the market in the urban centres in a quality accepted by the consumers. Realisation of the take-off will also mean a shift from the small-scale agri-businesses to large scale enterprises which can transform lives, so as to contribute towards realisation of the country's Vision 2030. Since the ultimate aim is to have longer life products, future research should focus on the development of milk products such as UHT and camel milk powder. Research should also focus on the nutritional impacts of camel milk technology development among pastoral peoples.

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