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Characterization of beef production chain in Pakistan

Die Lebensmittelkette „Rindfleisch" in Pakistan

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Summary

This paper presents a thorough analysis of the beef supply chain in Pakistan. Comprehensive meat inspection and hygiene management are implemented in export abattoirs, and in facilities supplying to large municipalities, whereas in the rural areas a short time from slaughter to consumption has to compensate for the lack of infrastructure, esp. cooling facilities. It would appear that the current food safety system in Pakistan is not well adjusted to managing major biological hazards and that traditional food preparation (cooking) techniques are still relied upon to ensure basic food safety.

Keywords: Pakistan, beef supply, beef consumption, risk management

Zusammenfassung

In dieser Arbeit wird eine gründliche Analyse der Rindfleischproduktion und -versorgung in Pakistan vorgenommen. Eine umfassende Fleischuntersuchung und Hygienemanagement sind in Exportschlachthöfen und Schlachteinrichtungen in Großstädten etabliert, während in den ländlichen Gebieten Mängel in der Infrastruktur, insbesondere, was Kühleinrichtungen betrifft, durch die kurze Zeitspanne von der Schlachtung zum Fleischverzehr ausgeglichen werden müssen. Das aktuelle Lebensmittelsicherheitskonzept in Pakistan ist anscheinend nicht gut geeignet, um die wesentlichen biologischen Gefahren in der Lebensmittelkette zu kontrollieren. Wahrscheinlich gewährleisten traditionelle Lebensmittelzubereitungstechniken das Basisniveau an Lebensmittelsicherheit.

Schlüsselwörter: Pakistan, Versorgung mit Rindfleisch, biologische Gefahren, Rindfleischverzehr, Risikomanagement

Introduction

Food security and food safety are among the major challenges worldwide. In less developed economies, most emphasis is put on food security, i. e. ensuring that an adequate supply of nutritious and wholesome foods is made available for the population, whilst the assurance of food safety generally relies on adherence to traditional production and processing techniques, that have 'empirically' been proven to be relatively safe. However, economic development is generally associated with changing production structures and consumer demands, which may dictate reconsidering current risk management approaches.

Although meat is not the dominant compound in the diet in developing countries, it is a valuable by-product of extensive animal (especially dairy) farming. Meat is prone to contamination with a number of biological hazards (Sofos, 2008), and assuring its safety requires a set of risk management procedures, ranging from *ante* and *post mortem* inspection to ensuring that clearly defined processing and (domestic) preparation techniques are adhered to. The shelf life of fresh meat can be extended by refrigeration, which, however, is an economic and logistic challenge in less developed geographical regions with high ambient temperatures. Consequently, in such regions – including Pakistan – the time interval between animal slaughter and meat consumption is generally very short, typically 1–2 days. Obviously, the latter neither applies to marketing and distribution of meat in large metropolitan areas, nor to muscle food consignments destined for export, for both of which stricter risk management procedures are necessary.

In this paper, we provide a review of the supply chain for beef and products thereof in Pakistan. In a companion paper (Nauman et al., submitted) , the major findings reported in this review shall be linked to the microbial food borne hazards identified in Pakistan, to allow assessment of consumer exposure and to assess the efficacy of control measures, and, ultimately, to rank beef borne microbiological risks.

Economic aspects of the livestock sector in Pakistan

The livestock sector plays an important part in the socio-economic development of Pakistan (which has an approximate total population of 185 million). The population living in rural Pakistan is 116 million, about 60 % of which (70 million individuals) is directly or indirectly employed in the agro-food production sector. Roughly one-third of the rural population [30 to 35 million (Halwai, 2008)] can more specifically be associated with livestock-related activities. The latter comprise the activities of mostly smallholders' families – consisting of landless labourers, marginal farmers and women – 40 % of whose income is dependent on the keeping of typically 3–5 cattle/buffaloes and 7–10 sheep/goats per family. This sector is a main supplier of raw material to many associated food processing industries, which produce meat and its by-products, milk, leather, gelatine, pharmaceutical products etc. and create markets and capital.

The livestock sector is contributing 56.3 % to Pakistan's agricultural value added production and 11.8 % to its Gross Domestic Production; the sector is still growing, e. g. 3.0 % over the period 2013/14. The meat producing livestock population in Pakistan in the period 2014/2015 was 41.2, 35.6, 29.4, and 68.4, million heads of cattle, buffalo, sheep, and goats, respectively (Anonymous, 2014).

It is estimated that the total annual output of meat in Pakistan amounts to 2.2 million tons, which makes Pakistan the 19th biggest producer of meat in the world (Yusufzai, 2013), holding the 2nd place for buffalo meat, the 4th for goat meat, the 11th for mutton and the 14th place for beef (FAOSTAT, 2012). However, its share of the US$ 300 billion global halal market outside Pakistan is just US$ 227.1 million, as Pakistan mainly exports meat to the Gulf Cooperation Council (GCC) countries (these are Saudi-Arabia, The UEA, Kuwait, Qatar, Bahrain and Oman) and by-products, particularly casings, mainly to Germany, Romania, Spain, Italy and Poland (UNIDO, 2012).

Meat is exported as refrigerated whole carcasses or carcass quarters, which have a very limited shelf life in comparison to the frozen product, and represent no added value for producers. As regards the chilled whole carcass category, Pakistan is a major supplier to many GCC countries; its share in the marketing of higher value boneless and value added chilled/frozen meat and meat products is close to zero. In recent years, the demand has increased, as shortages of domestic livestock in GCC countries have forced local food control authorities to relax safety standards for imported meat. Although beneficial for current Pakistani export, entirely relying on this particular market would appear to be precarious in the long term, i. e. when marketing conditions may change.

Thus, it is vital to gain access to other markets, which may include e. g. the Commonwealth of Independent States (CIS), the Association of Southeast Asian Nations (ASEAN) and the Organization of Islamic Cooperation (OIC). To achieve access to the latter markets, strict adherence to internationally recognised acceptability standards in terms of food safety, and diversification in offered products range and focussing on consumer health is vital (UNIDO, 2012). Consequently, Pakistan needs to develop an improved institutional and regulatory laws' infrastructure and to eliminate all possible hurdles which are compromising the country's ability to freely export fresh meat. This particularly relates to Pakistan's animal disease status and associated restrictions by the World Organisation for Animal Health (OIE) of exports from countries where Foot and Mouth Disease (FMD) is endemic. This disease is occasionally diagnosed in Pakistan, and consequently, attempts are made to eradicate this disease to reach FMD-free status. Up to now, no case of BSE has been reported in Pakistan; however, a BSE-free status is not recognized by OIE. Yet, this restriction could possibly be overcome by creating and recognizing disease-free zones and farms particularly for export purposes. In pursuing this aim, the private sector can help to exploit the potential for the improvement of per-unit-productivity to meet food security requirements. The latter can, for instance, be achieved by providing schemes for technical assistance, vaccination, medication and marketing, which could make Pakistan's livestock production system more sustainable and viable (Chaudhry et al., 1999). The public sector could contribute by making favourable policies and by creating a suitable investment-friendly environment.

Journal of Food Safety and Food Quality 67, Heft 2 (2016), Seiten 29–60

Characterisation of the beef chain in Pakistan from livestock to slaughter

In Pakistan's beef chain many players are involved, from producer to local seller and exporter (Fig. 1). As regards dairy herds, males and purpose-fattened veal calves are primarily sold on the local market, i.e. carcasses and parts thereof will usually end up at the local butcher; only a very small percentage is destined for export. Producers are mostly small farmers who are rearing the animals as 'cash whenever they need it', e. g. to cater for unexpected or joyous occasions. In this system the middle man always remains the main beneficiary as he collects the animals and sells them to butchers and meat processors.

Animals which are utilised for beef production are mostly from 'dual purpose' (milk/meat) breeds. Males, non-productive females and animals at the end of their productive life are destined for meat production. Male calves are slaughtered at an early age well before they reach their maximum potential weight. Whilst dual purpose breeds generally have a lower growth rate (lower feed conversion) than specific meat breeds, this is (from a production costs' point of view) partly compensated for by the local farmers rearing the animals mostly on agricultural by-products. Carcass yield, approximately 52 %, is quite low as compared to the 62 % recorded for particular beef breeds (Fayyaz et al., 2004; Ahmad et al., 2013).

A significant factor hindering improved production efficiency is the fact that the latter – as a rule – is judged on the basis of the number of offspring produced rather than on their meat yield, as there are currently no such standards implemented in Pakistan's meat trade. Hence – in general practice – middle men, butchers and slaughterhouses purchase the animal merely on the basis of appearance and estimated weight.

Traditional meat production in Pakistan depends on farmers for whom it represents a posteriority, as a result of which this 'low input/low output' system still prevails. Thus, traditional meat marketing discourages the breeder and remains a constraint in the development of the meat industry as the current meat marketing system provides almost no incentive to produce high quality meat. Professional itinerant animal traders largely dominate the animal markets (especially in remote areas) and individual farmers cannot break traditions and monopolies of this marketing system.

Many other impediments are relevant such as i) government price-capping policies (counterproductive for the producer), ii) lack of awareness in the farmers' communities of modern farming practices, iii) lack of integration between the livestock supply- and value-chain, iv) ineffective service delivery mechanisms, v) absence of rural infrastructure, vi) scarcity of trained and skilled workers, vii) genetic potential deterioration (resulting from the mixing of different gene pools), viii) inadequate feed resources, ix) fragmented farm base and seasonal breeding hindering livestock sector performance and discouraging the producers(USAID, 2009; UNIDO, 2013), x) lack of value addition or grading system, and last but not least xi) the absence of reliable systems allowing traceability of slaughtered herds, which probably represents the biggest hurdle for meat export to developed nations in which such is mandatory.

A recent trend in industrial animal production is the fattening of animals in feedlots contractually allied with dairy farms and relying on low cost feed formulations. This development may help to a) exploit the animal's innate potential for a more efficient feed conversion and b) change the traditional practice of unnecessarily early culling of male calves at dairy farms in an attempt to avoid rearing costs. Whilst a feedlot fattening system is more costly as compared to conventional systems, it allows more efficient disease control and the production of good quality meat and thus improves export perspectives.

Meat production animals are supplied from various parts of the country: small ruminants primarily from the Sindh, Balochistan and Khyber Pakhtunkhwa (KPK) provinces, large ruminants from the Sindh and Punjab provinces. This relates to the topography of these regions, ranging from the world's highest mountains (in Balochistan and KPK) to fertile plane lands in Punjab and Sindh. Transportation means are mostly trucks and vans which are not specifically designed- but rather merely modified for this purpose at particular occasions. The distances from the rearing sites to market or slaughter house may exceed one hundred kilometres (Fig. 2). In Pakistani practice this means transport durations of several hours at temperatures up to 50 °C in the summer season, for which reason transportation at night is preferred to save animals from dehydration and fatigue.

Provision of beef to consumers via the formal and informal sector

In the provision of beef to the consumer, the formal sector has to be distinguished from the informal sector.

The formal sector

The formal sector comprises the properly established slaughter houses, some of them having their own further processing units for e. g. cooking, fermentation and other means of preservation and principally selling at their own

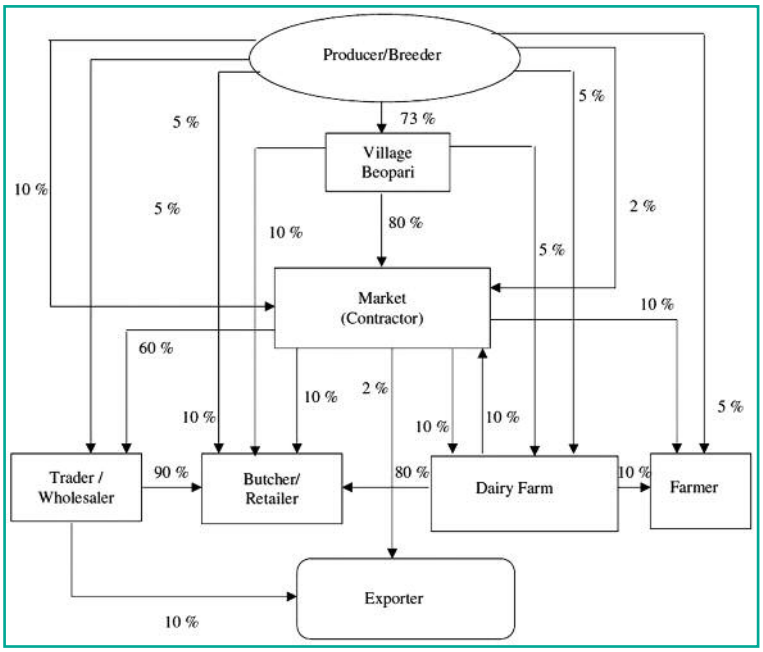

FIGURE 1: *Flow sheet of cattle supply chain in Pakistan (according to Sharif, 2011).*

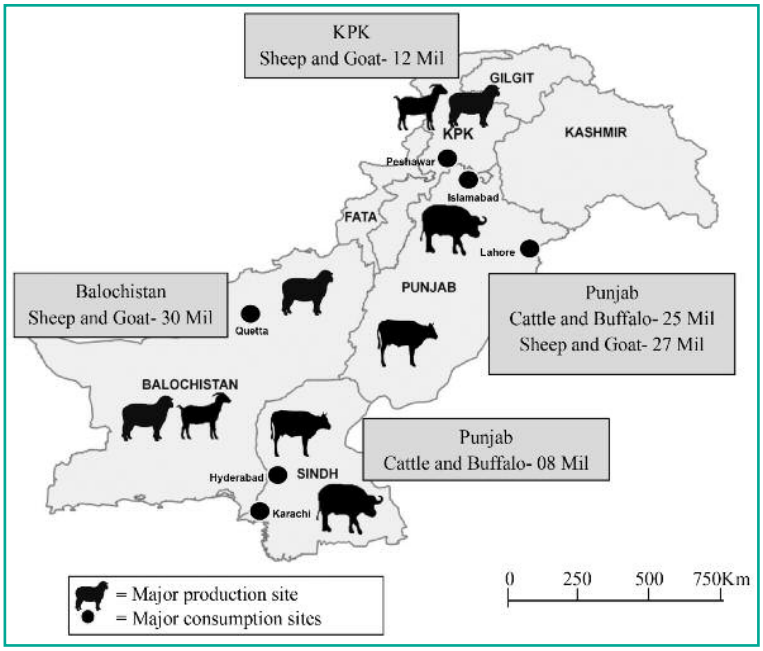

FIGURE 2: *Livestock rearing sites (indicated by animal symbols) and major meat processing and consumption areas (indicated by black dots) in Pakistan.*

and at franchised retail shops. According to an economic survey in the 2014–15 period, 29 slaughter houses were recognised as exporting meat to different regions of the world. Although most of these abattoirs are owned by diversified corporations, some are small private companies. These companies export raw chilled mutton/sheep meat and beef/buffalo meat to the Middle and Far East countries. Generally such abattoirs are newly established, well equipped, have capacities of up to 2000 small and 700 large ruminants per day and are certified by various international bodies for processing quality and hygiene. These firms also have chillers for storage and reefers for transportation of meat. Such facilities are located in and around major municipalities like Lahore, Karachi, and Islamabad, but their share in beef production and distribution for the domestic supply is minimal.

The second category in this sector comprises big retail stores, some of which buy live animals for slaughter and subsequently distribute the meat via a chain of retail outlets all over the country. Some companies purchase carcasses or primal cuts from slaughter houses and then display these for sale.

An emerging final category comprises big industrial groups targeting both the domestic and export market and aiming at developing a back end supply chain (i. e. developing their own animal rearing facilities to supply their own slaughter houses) to assure a continuous and smooth supply of disease-free animals produced according to specific standards tailor-made for their facilities. Product specifications are determined and closely monitored according to country and ordering firm. These specifications include for instance male: female ratio, weight range, age, animal condition, labelling, traceability, controlled temperature through refrigeration & freezing and defined shelf life. Although helpful in informing and educating farmers and processors about certain Good Manufacturing Practices, the monitoring of safety and quality parameters (in the absence of formal grading standards and independent control bodies) still hinges upon the performance of the concerned individuals. The butchers working in this sector are generally experienced and mostly have received 'Father to Son' training. Experienced and well versed workers are allowed to work on modern machinery to avoid any deviation from standard working protocol.

In the formal sector, meat inspection is conducted by qualified veterinarians. Some of these are provided opportunities to receive additional education from international training institutes and may later on organise and supervise similar training activities for junior vets.

The informal sector

The informal sector is the common sector for most of Pakistan. A butcher buys livestock from the animal markets, which are held on scheduled days. Animals are slaughtered in government owned slaughterhouses or – illegally – in private facilities (which is particularly the case in small cities and villages) (Fig. 3). Meat is supplied to sale points by one butcher or a group of butchers, who slaughter on demand.

These slaughtering facilities produce meat for the traditional 'wet markets', where meat is sold fresh and unrefrigerated. These slaughterhouses can be found in almost all cities and are managed by local municipalities. With the continuous expansion of old cities and the emergence of new small towns, the number of such slaughterhouses (309 countrywide in 2010) is increasing day by day (FAO, 2010). These abattoirs confront many difficulties like low capacity, untrained manpower, and an inadequate infrastructure resulting in insufficient adherence to Good Manufacturing and Hygienic Practices (Jalil et al., 2013). Workers in the informal sector receive training 'on the job', but have generally not enjoyed any kind of formal education.

There is considerable concern about illegal slaughtering (FAO, 2010), particularly in fields, isolated rural areas, backyards, and other unlicensed locations which are used to slaughter small ruminants to avoid inspections and

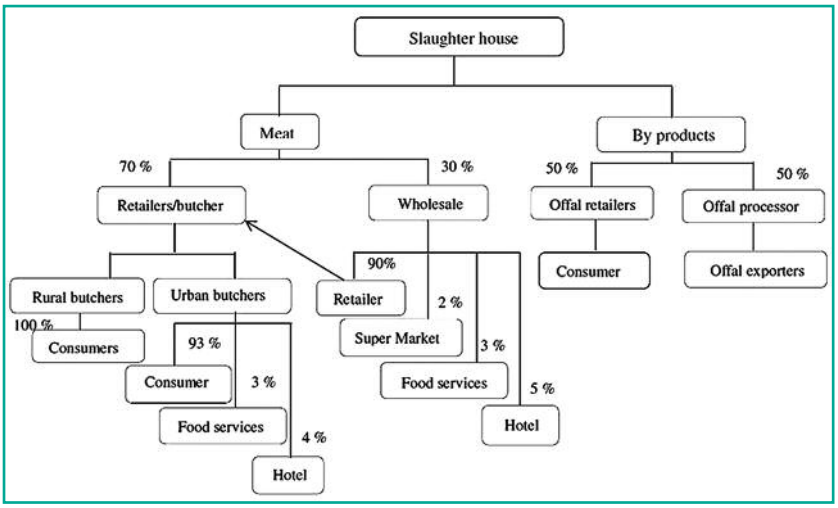

FIGURE 3: *Current product flow in the beef-mutton-buffalo meat-goat meat distribution chain in Pakistan.*

Journal of Food Safety and Food Quality 67, Heft 2 (2016), Seiten 29–60

slaughter fees. In the informal sector, most frequently reported malpractices include : i) water injection in meat to increase weight, ii) slaughtering of old and diseased animals, iii) selling meat of dead animals and slaughtering of 'haram' (forbidden in Islam) animals (Faisal, 2011). Such could be avoided by proper implementation of laws and by proper coordination in law implementing departments.

Although meat inspection is indeed conducted by qualified veterinarians (as a 'side-job' to their more regular governmental employment e.g. as a veterinarian in animal health or artificial insemination), these veterinarians do not have particular training in meat inspection and fulfil their additional responsibilities merely on the basis of their basic pathological-anatomical knowledge and experience. Their performance is further complicated by legislative flaws (e. g. outdated laws not providing sufficient solid opportunities for prosecution of malpractices) and, generally, their unawareness of science-based arguments that would hold up in court cases.

Associated with the informal sector are 'meat shops', which are located on every location and are not necessarily to be found on the premises of particular meat markets. Another major concern is the proper handling and transportation of meat: meat is mostly transported on horse draught carts, which practice poses severe public health threats due to the unhygienic transport conditions generally observed.

Current status in control and management of biological hazards in the beef chain in Pakistan

Institutions involved in animal health and food safety

Food import and export are regulated by the federal government whilst food safety standards are regulated by the provincial authorities. Generally, current controls are commodity-based (e. g. foods of plant origin, livestock, fish etc.), reflecting the different functions of the various government departments.

At federal level, the Ministry of National Food Security and Research (MNFSR) is actively involved in policy formulation, inspection, livestock and agricultural products, poultry and fisheries through different related institutes while the Ministry of Science and Technology, the Ministry of Health and the Ministry of Commerce are responsible for standardizing formulation, testing and regulating food items including labelling and shelf life.

At provincial level the Department of Health is responsible for food safety in retail/ catering and processing establishments for the national market, whilst the Livestock & Dairy Development Department deals with meat inspection at farm/slaughterhouse level and with poultry products inspection at the primary producer's level.

Legal provisions

Currently the Health Department, the Food Department and the Livestock & Dairy Development Department (L&DDD) are responsible for controlling different segments of the beef supply chain. A complex inspection system is relied upon, which occasionally creates controversies between the responsible departments due to overlapping of responsibilities.

Food safety and food quality are regulated by a set of laws dealing with various control aspects (Tab. 1). Although many of these laws were enacted several decades ago, in some cases the original legal formulations are still valid. However, through the addition and deletion of clauses or amendments one has at least achieved a minimum level of food safety. Yet, in general, many laws remain very poorly enforced and still have many flaws which hinder their proper implementation.

TABLE 1: *Summary of laws pertaining to different segments of the beef supply chain in Pakistan.*

Field of application	Legal provision/year of enactment
Product Safety	Local Government Ordinance, 2001 West Pakistan Pure Food Ordinance, 1960 The Punjab Food Authority Act, 2011
Slaughter houses	Slaughter control Act, 1963 Goat (Restriction) ordinance, 1959 Local Government Ordinance, 2001
Markets of Animal products	Local Government Ordinance, 2001 Punjab Agricultural Produce Markets Act, 1979
Packaging, storage and distribution of Animal Products	Agricultural produce (Grading and Marketing) Act, 1937/Rules
Animal welfare	Prevention of Cruelty to Animal Act, 1890 Cattle Trespass Act, 1871
Price Control	Price Control and Prevention of Profiteering & Hoarding Act, 1977
Import/Export control	Pakistan Animal Quarantine (Import and Export of Animal and Animal Product) ordinance, 1979
Standardization of standards	Pakistan Standards and Quality Control Authority Act, 1996

Inadequate legal framework, weak enforcement mechanisms, less visible role of stakeholders, dispute resolution, absence of supply chain, lack of value addition, discouraging of competition by price capping and the lack of implementation of internationally recognized 'good practices' are among the major flaws of the Pakistani control system (USAID, 2011). To cope with this situation, at least the Punjab province has extended the existing laws by introducing additional provincial legislation (e. g. Punjab Pure Food rules 2007, The Milk and Meat Safety Act 2011, Punjab Food Safety and Standards Authority Ordinance 2011, Punjab Livestock Market rules, 2012, Punjab Quality Meat and Slaughter Regulation Act, 2013), which support the controlling authorities in dealing with some of the deficiencies in federal legislation.

To improve the existing food safety and security conditions in the province and to overcome some of the traditional bureaucratic hurdles, Punjab has established two institutions i. e. the Punjab Agriculture and Meat Company (PAMCO, in 2010) and the Punjab Food Authority (in 2011) in an attempt to ensure that the regulations of the legally responsible governmental departments are properly implemented.

Meat inspection

Given the current structure of the beef chain, it seems that there is lack of biosecurity at primary production and it is unlikely that this situation will readily change in the short term future. Thus, meat inspection, as a sort of 'end product control' has to be relied upon for revealing deficiencies in primary animal production and for detecting and eliminating meat borne public health risks. Pakistan relies on classic meat inspection (including incision and palpation) which focuses on identifying macroscopic pathological-anatomical alterations. However, such an approach fails to

detect animals which are symptomless carriers of zoonotic pathogens (Vågsholm and Smulders, 2012), which are shed during transportation and in lairage and will inevitably result in microbial contamination of meat surfaces during slaughtering and processing.

Meat consumption and preparation

Meat consumption

In Pakistan, the food (including meat-) consumption pattern has undergone massive changes over the past two decades (Malik and Babar, 2005). Estimated figures for meat consumption for different meat species are 8.3 kg of beef/buffalo meat, 4.9 kg of mutton/goat meat and 3.2 kg of poultry meat per capita and per year (PBS, 2011). Total meat consumption is expected to increase to 18.1 kg in 2020 (Rosegrant et al., 2001). As a general trend, goat meat is preferred over all other meat species (assuming it is available); even when its price is double that of beef. Recently, consumption of mutton declined by 12 % with poultry replacing 8 % and beef the remaining 4 % (Anonymous, 2014). Official statistics indicate that beef, mutton and chicken constitute a minor part of the average diet with 0.2; 0.02 and 0.22 kg per month compared to a total food consumption of ca. 24 kg (3rd quantile; PBS, 2011). The top 20 % of the population consumes 0.35 kg beef per person and month. Differences between urban and rural consumers are less pronounced. Assuming portion sizes of 150–200 g meat, it can be estimated that high beef consumption equals 1 beef portion/week and average consumption 1 portion per 2 weeks.

Projections on future beef & veal consumption in Pakistan predict a 3.04 % overall growth in *per capita* consumption from 2011 to 2020 (Note: over the 2001–2010 period corresponding figures were 6.04 and 3.86 % respectively) (OECD/FAO, 2011).

Meat preparation

It is estimated that 4.86 million Disability Adjusted Life Years (DALYs) were lost in Pakistan due to diarrhoeal disease in 2014, accounting for 5.71 percent of the DALYs loss from all other causes (WHO, 2014). Remarkably, to date no significant food borne illness outbreak in Pakistan has been documented (Akhtar et al., 2012), most probably due to underreporting and/or insufficient structures in disease monitoring and surveillance.

In essence, the domestic meat preparation tradition in Pakistan involves thorough heating (see below), although the finished meal may be stored for several hours at ambient temperature (Bryan et al., 1992), which obviously favours multiplication of bacteria surviving heat treatment or of those having been introduced into the heated meal through cross contamination.

The Pakistani population is generally not inclined to consume meat in raw- or semi cooked form (Mumtaz et al., 1986). Meat is usually (stir-)fried for a short period and subsequently combined with other ingredients and boiled for 0.75 hrs or more [e. g. 'Bhuna Gosht' with curry; Nihari; 'Keema (Minced meat) Curry'; 'Keema (Minced meat) Mattar'], larger cubes sometimes in more or less thick sauce ('Beef Qorma'; 'Beef Tikka Saalan'). Meat balls or patties may be boiled in sauces ('Nargisi Koftay', 'Koftay'); minced beef can also be combined with yoghurt and then boiled ('Hari Mirch Keema'). Chili Beef consists mainly of fried beef stripes.

Conclusions

Meat is a highly valued food in Pakistan, and beef export can help to develop local businesses. Beef production is traditionally a side branch of keeping dairy and draught cattle, but there are initiatives to specialize in fattening of cattle for slaughter. The demand for beef and also for "novel" beef products is expected to rise at least in the urban centres of Pakistan. Although the formal meat chain involves a food control system, there is a lack of knowledge on the prevalence of zoonotic hazards in the beef chain, and the inspection system is not focused on the hazards of most concern. This, together with expected changes in beef production and processing is very likely to cause hazardous situations.

It is doubtful if the current food safety system in Pakistan is well adjusted to managing major biological hazards; in this situation, traditional food preparation (cooking) techniques is still relied upon to ensure basic food safety.

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Conflict of interest

The authors declare that no conflict of interest exits.

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