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Introduction and background

The dairy value chain in Kenya plays an important role in the economy, providing jobs for smallholder milk producers and nutrient-rich milk and dairy products for consumers, the most important of which are families with infants below the age of four. The share of dairy products accounts for 30% of livestock gross domestic product (GDP) and 4% of the country's total GDP (USAID 2010; Muriuki 2011). The demand for milk and milk products in Kenya is among the highest in developing countries (SDP 2004), while milk consumption in Kenya is one of the highest in the East Africa region. The country's annual per capita consumption of milk and dairy products has been estimated at 19 kg in rural areas and 125 kg in urban areas (FAO 2011) and is projected to reach 220 kg by 2030 (KMT 2017). Depending on location and socio-economic class, milk consumption may vary between 50 and 150 litres per capita and per year (Bosire et al. 2017).

There is a common perception among Kenyan consumers that milk and dairy products are healthy and nutritious. Studies have found that consumers in Kenya generally boil their milk before its consumed, thereby decreasing the number of pathogens in it. However, in addition to the presence/number of pathogens in the milk, there are also other quality and safety issues (e.g. milk adulteration with water, addition of antibiotics or other chemical preservatives, aflatoxin contamination etc.) that persist even when milk is boiled prior to consumption. It is also important to note that it is not possible to boil other dairy products such as yoghurt, fermented ('mala') milk and butter.

Assessing consumers' attitudes, perception and knowledge about milk quality and safety in Kenya is a fundamental step towards ensuring that policymakers are provided with the necessary information to develop and implement policies that protect consumer health. It also provides valuable information for the dairy value chain actors and stakeholders to improve their practises and provide quality and safe milk. It is in this perspective that the current study was undertaken under the auspice of the Voice for Change Partnership (V4CP) program.

Before moving to the next section, we provide some key definitions about the terminologies used in this report. Raw milk (generally not chilled) refers to the unprocessed milk that is sold to consumers through the 'informal' marketing channels. Raw milk is mostly sourced directly from the producers, mobile traders/hawkers and from milk bars/shops. Processed milk is the milk that has gone through a processing activity like pasteurization (traditional or industrial), ultra-high temperature (UHT) treatment, and is then packed in different volumes and package types (e.g. tetrapack, plastic bottles and pouches). In the Kenyan market, it is also possible to find unpackaged processed milk being sold from milk vending machines/dispensers (which are known as ATMs) or milk bars.

Objectives

The main objective of the study was to assess consumers' perception and risk attitude towards milk quality and safety in Kenya. The study also analyzed consumers' willingness to pay for safe milk and dairy products. Specifically, the study focused on the following areas: consumers' milk purchase and consumption habits, factors influencing consumers' choice, consumers' risk attitude towards milk safety, consumers' willingness to pay (WTP) for safe milk, and consumers' perception of product labelling.

Methodology

This study reflects and builds upon existing literature related to milk consumption and consumers' perceptions of milk in Kenya. This includes studies done by national and international research organizations and universities, as well as the private sector and other dairy stakeholders. The focus was on the main objectives of this review and the presentation of the details about each study (region, type and number of respondents, and year the study was done, among other aspects) to provide a clearer picture of the context and the reliability and generalization of the results. At the end of each subsection of the results section, the main findings are summarized upon which are built the conclusions and recommendations.

The findings from the literature review have been consolidated and discussed with a few stakeholders who are directly or indirectly involved in the dairy value chain in Kenya.

Consumers' milk purchase and consumption habits

Milk production in Kenya is dominated by smallholder dairy farmers who contribute more than 70% of gross marketed production (Walke 2014). Milk is marketed through either the formal or informal market channels. The formal milk market channel generally sees the sale of milk that has been processed (pasteurized, UHT etc.) by registered dairy companies and retail outlets, while the informal milk market channel mainly consists of the sale of raw milk and some volumes of fermented ('mala') milk by producers and unregistered hawkers and mobile traders. The majority of milk produced and marketed in Kenya (around 86% of total volume) is still sold through the informal channel (KMT 2016; Omore et al. 2000). In 2012, Kenyans consumed around four billion litres of milk (MoALF 2013), the formal dairy channel/sector recorded a total intake of about 495 million litres during the same year (KDB 2017) representing 15% of the overall supply.

Kenyans' milk purchase and consumption habits are thus directly linked to and influenced by the type of marketing channel: formal vs informal. There are also other factors that affect milk purchase and consumption such as the residential area: rural vs urban. In rural and suburban areas, the majority of consumers buy raw milk directly from the producer or kiosks and smaller shops. In urban centres, the two different types of milk compete as they are sold in more or less the same retail outlets. Kiosks and shops near residential areas sell both processed and raw milk (ACET 2015; Muriuki 2011; Schneider 2018).

Walke (2014) and Walke et al. (2014) analyzed Kenyan milk consumers' purchase and consumption habits in Dagoretti (a peri-urban area of Nairobi) with a focus on aflatoxin knowledge and perception. Respondents (310 persons) were mainly of low-income households, with the majority of households earning less than KES30,000 (USD345) per month. The study found that 95% of respondents bought raw milk and only 5% preferred processed milk and opted for raw milk thereafter. Women are more often responsible for the households' milk purchase than are men. Shops (40%), followed by milk bars (25%) and milk producers/farmers (25%) are the main places/outlets where consumers buy milk. Kiosks and hawkers were also mentioned by respondents but with lower percentages (15% and 10%, respectively). More than 90% of respondents bought milk once a day on average, likely reflecting the fact that the majority do not have refrigerators at home and wish to preserve the freshness and quality of the product. The majority of households (38%) bought 1 litre per purchase occasion, followed by 0.6 litre (18%) and 0.5 litre (12%).

Schneider (2018), in her study of milk consumers (200 respondents) from low income households (less than 30,000 KES/month) in Dagoretti, found similar results related to milk outlets. Primarily, households bought their dairy products from a corner shop or kiosk (40%), milk dispenser in a milk bar (16%), directly at the producer's gate (12%), or from a milk bar in a dairy shop (11%). Most households only bought their dairy products from one market outlet (79%), whereas 2% bought their dairy products from a different market outlet every day. On average, the outlet was about 6.6 minutes walking distance which indicated good access to the milk market for households.

Fadiga and Makokha (2014) conducted a study on milk and meat consumers in two cities in Kenya, Nairobi, the capital city (169 respondents) and Eldoret, a large city located within an agriculturally-rich area (119 respondents). The study found that the milk products consumed the most were packed pasteurized milk (21%), raw fresh milk (17%),

fermented packaged milk (12%), and yoghurt (13%). In Eldoret, fresh milk was the most popular dairy product, while in Nairobi packed pasteurized milk and yoghurt were the most popular. Fresh milk was consumed mainly by low-income households earning less than KES 30,000/month.

In terms of consumption, Walke (2014) and Walke et al. (2014) found that almost half of the respondents (48%) consumed milk daily or several times per week where the quantities of 300 ml, 600 ml and 900 ml were the most frequently used. In general, the quantities consumed vary from small amounts used in tea to amounts of more than one litre. One third (31%) of respondents consumed milk occasionally and 21% never consumed milk. Results showed that 67% of the infants (less than 3 years old) in the interviewed households drank cow milk every day, and 59% of children (between 3 and 18 years old) consumed raw milk (after boiling) daily or several times per week.

Walke (2014) and Mtimet et al. (2015) analyzed middle- and high-income consumers' purchase and consumption habits (299 respondents) in Nairobi with a focus on aflatoxin knowledge and perception. The authors found that for all respondents (100%) processed milk was their first choice, while for 9%, raw milk was their second choice. Women were more responsible for households' processed milk purchase like in the case of raw milk survey. The preferred purchase places of processed milk by consumers were super/hypermarkets (77%) and shops (65%). Kiosks, milk bars and hawkers only played a minor role as purchase places. A high proportion of consumers (69%) bought milk once a day or more. Due to the common packaging sizes, 57% on consumers preferred buying 0.5 litre per purchase occasion followed by those who opted for 1 litre packs of milk (20%).

In the same study, the authors (Walke, 2014; Mtimet et al., 2015) found that almost half of the respondents' consumed milk daily where the quantities of 250 ml, 300 ml and 500 ml were the most frequent. In general, the quantities consumed varied from small amounts used in tea to amounts of half a litre. Around half of the respondents (48%) consumed milk every day, while less than half (39%) consumed milk several times a week or occasionally, and 13% said they never consume milk. For the households who have infants, 65% of them indicated that their infants drink milk daily, while for the households with children above 3 years old who drink milk daily the proportion was 58%.

Schneider (2018) found a direct correlation between income and expenditure on dairy and food products. Generally, the higher the income of a household surveyed, the higher the weekly expenditure on dairy items and food products. Average expenditure on dairy products amounted to almost KES400 per week (13% of total food expenditure). Due to the sampling strategy (i.e. targeting households that consume raw milk), almost all households (99%) purchased unpacked raw milk daily. Packed yoghurt (40%), packed pasteurized whole fresh milk (17%) and UHT milk (7%) were the other most purchased dairy products (in addition to the raw milk). Unpacked and packed fermented milk as well as unpacked yoghurt and powdered milk were bought by less than 2% of participating households. Other dairy products like ghee, butter, cream or cheese were not purchased.

Schneider (2018) also found that the majority (99%) of the children aged 6 to 48 months consumed raw milk the week previous to the survey visit, followed by packed yoghurt (40%) and packed pasteurized whole fresh milk (17%). Most children who consumed dairy products as bought, consumed them either as unpacked raw milk or packed yoghurt (43% and 42%, respectively). Only 7% of children consumed packed pasteurized whole fresh milk as it was bought.

From the supply side, Alonso et al. (2018) in their study of milk producers, traders and vendors in Kisumu and Eldoret indicated that from the 67 vendors interviewed and operating in the informal dairy sector in the two cities, about two-thirds of the traders sold value-added products in addition to liquid milk i.e. mala or fermented milk (64%) and yoghurt (21%).

Muriuki (2011) indicated that in rural and suburban areas of Kenya, consumers buy mostly unprocessed milk directly from producers, kiosks, neighborhood shops and hotels. In urban centres, unprocessed and processed milk compete, using more or less the same retail outlets, although some, such as supermarkets, do not sell raw milk. Shops and kiosks near residential areas retail both processed (packaged) and unprocessed milk. The author also mentioned that among the main challenges for the dairy industry in Kenya is the high consumption of unprocessed milk, even in urban centres, and the relatively high consumption of milk (both raw and processed) compared with value-added processed dairy products.

Bebe et al. (2018) in their study about consumers' (368 respondents) milk purchase and quality perception in four counties in Kenya (Nairobi, Nakuru, Uasin Gishu and Kakamega) found that raw milk purchase (average of 6 litres/household/week) is higher compared to packaged milk (3.3 litres/household/week), fermented milk (1.2 litres/household/week) and milk fat and powder (less than 0.5 litre/household/week). Households' weekly expenditure is still higher for raw milk (KES350) but the gap with the other dairy products (packaged milk, fermented milk, etc.) is lower because of the price difference. The authors found that raw milk is bought from different outlets (directly from the farm, mobile traders, milk bars, shops and kiosks) while processed milk, fermented milk, and milk powder are mainly bought from supermarkets.

Njarui et al. (2011) conducted a study on the consumption of milk and milk products in the semi-arid region of eastern Kenya (Machakos County and town). A total of 135 rural and 126 urban households were studied. Raw milk was the most popular and was consumed by 99% and 84% of rural and urban households, respectively. Raw milk was most preferred followed by pasteurized milk while powdered milk was the least preferred. In the rural areas, milk shops/bars and neighbours with dairy cattle were the major source of raw milk. For the urban households, a large proportion of raw milk was supplied by hawkers. Milk shops or bars located strategically in urban residential areas were also important sources of raw milk. Household residential area and income were the significant factors affecting milk and dairy products consumption. In fact, urban households consumed 16 and 12 litres/month more raw and pasteurized milk, respectively, than rural households; and the higher-income households consumed more milk and milk products than the low-income group.

The authors (Njarui et al. 2011) found that generally, as the level of milk processing increased, the frequency of milk consumption declined in households in semi-arid areas from more than once per day to 1–2 times a week and eventually to occasionally. The authors recommended improving the availability of milk and milk products to improve their consumption particularly in the rural areas.

Cornelsen et al. (2016) conducted a survey (205 households) in peri-urban Nairobi (Dagoretti and Korogocho) assessing the drivers of demand for animal-source foods (ASF). They found that nearly all households (91%) purchased milk in the previous week, which accounted on average for 47% of all the total ASF expenditure.

Research Solutions Africa (2013a, 2013b) conducted a survey among low-income urban consumers (304 households) in Nairobi County, who had recently consumed both raw and processed milk. The authors found that of the money spent on food at home, about 20% was spent on dairy products, and the overall per capita milk consumption among low-income urban consumers was significantly lower compared to the average 125 kg found in other studies. The authors found that more than 71% of respondents drank milk only once a day, mostly in the morning. A further 23% consumed milk twice a day, adding an evening cup of whitened tea. More than half of respondents (54%) consumed the milk in the form of whitener in their tea with no significant difference between pasteurized or raw milk, and 27% drank the milk pure. The preferred sources of pasteurized milk were supermarkets (51%) and shops (34%), and 500 ml packs were the most commonly bought. Raw milk sources were more diverse: vendors (34%), milk bars (28%), shops (22%) and kiosks (12%). Around a third of respondents (36%) consumed milk outside their homes. Respondent said that the most important reason for consuming milk in the morning was because it is a source of energy (34%). In the afternoon and evening, reported reasons for consuming milk were its being part of a meal (ugali/sweet potatoes) or as a desert after a meal (combined 40%) and feeding a baby or a child (22%).

Main findings on consumers' milk purchase and consumption habits

Many studies indicated lower per capita consumption of milk and dairy products (around 50 litre/year) compared to the national average of 125 kg/capita. Per capita milk and dairy products consumption in urban areas is higher compared to rural areas.

Milk is considered as a source of energy for adults and an important food product for children's nutrition.

The majority of the studies focused on low-income households which, considering the income distribution of Kenya's population, represent the largest share of the population and the largest group of milk consumers.

Milk is mostly sold as raw through the informal sector. Processed milk is sold through the formal sector, although there are also some raw milk volumes that are sold through the formal sector.

Milk is frequently bought at least once a day but there is small proportion of households buying it twice or thrice a day. This is by consumers of raw milk and processed milk.

For low-income peri-urban consumers, the kiosk or shop ('duke') and the milk bars are the main sources of purchased milk. The quantities of 300 ml, 600 ml, and 900 ml are the most popular.

For middle- and high-income urban consumers, supermarkets and shops are the main outlets for milk purchase. Half a litre is the most popular quantity bought followed by 1 litre.

Peri-urban consumers are very loyal to the outlets from where they buy milk daily. Rural consumers mainly buy raw milk directly from the farm or from milk shops/bars.

Except in Nairobi city, raw milk is the most consumed by both rural and urban consumers in other regions in Kenya. In agricultural production cities such as Kisumu and Eldoret and in rural and suburban areas, raw milk is the most popular followed by fermented milk, while in Nairobi, packed pasteurized milk and yoghurt are the most popular. Middle- and high-income consumers in the capital city prefer buying processed milk.

Raw milk, pasteurized milk, fermented milk and yoghurt are overall, and in decreasing order, the most consumed products. The higher the level of processing of a milk product, the lower the frequency of its consumption.

Milk consumption is generally done on daily or several times per week for around half of low-income consumers. When it comes to infants and children below 18 years of age, the proportion of regular milk consumers (daily or several days per week) is higher (around two thirds). These findings are almost the same for low-income peri-urban consumers and middle- and high-income urban consumers.

Women are the ones mainly involved in buying milk and dairy products. This was observed in both the low-income and middle- and high-income population.

Household income is positively and directly correlated to milk and dairy products expenditure. The higher the income, the higher the household expenditure on milk and dairy products.

Very few studies have assessed milk consumption outside the home. One study mentioned that an overall proportion of 36% of respondents (low-income urban consumers) consumed milk outside the home.

Factors influencing consumers' choice of milk type and source

There are many factors that influence Kenyan consumers' choice of milk retail outlet and the type of milk purchased. Mtimet et al. (2015) employed a choice experiment technique which found that price, aflatoxin-free certification, the type of packaging (tetrapack, plastic, pouch) and the fat content of milk are the most important factors influencing consumers' choice for processed milk. In another study of raw milk consumers, Walke et al. (2014) using the same technique, found that price, the smell of the milk, and aflatoxin-free certification were the most important attributes influencing consumers' choice.

Fadiga and Makokha (2014) conducted a rapid market assessment (RMA) in which dairy and meat supply chain actors were interviewed to gauge the quality and safety attributes they perceived as being important for consumers. The main attributes cited were hygiene (visual evaluation if the milk is clean or unclean), packaging, colour, smell, and price. In terms of importance of these attributes, the rating was as follows: hygiene (8.8), smell (8.6), colour (8.0) and packaging (7.9). The mean rating of each attribute was consistently higher in Nairobi than in Eldoret. The difference is most striking for packaging, rated 8.8 in Nairobi compared to 6.6 in Eldoret. The respondents in the highest income bracket had the highest mean rating for each attribute.

The same authors (Fadiga and Makokha, 2014) used a conjoint experiment to assess the importance of the proposed attributes and their corresponding levels in milk consumers' choice. The study found that price was the most important attribute in determining preferences at 41%, followed by smell (31%), hygiene (15%), and colour (12%). Clean, less odorous, and cream-coloured milk had a higher preference level among consumers than polluted, foul-smelling, and white milk respectively. Packaging appeared to be irrelevant at the sample level, as there was no significant difference between milk in sealed packaging versus that in unsealed packaging. However, Nairobi consumers showed a preference for milk in sealed containers compared to those in Eldoret. Low-income consumers were indifferent with respect to packaging, while consumers in middle- and high-income households showed a preference for milk in sealed packaging.

Schneider (2018) found that a preference for processed vs raw milk or the opposite (raw vs processed) is not very clear and depends on consumers. In fact, 48% of consumers believe that raw milk is of worse quality than processed milk, 46% said that raw milk is of better quality, and for 6% the quality was the same. Households were also asked whether they would prefer to buy raw or packaged milk if the price of both were the same. Results found that 54% of respondents would opt for packaged milk and 44% for raw milk, showcasing that consumers' preferences are divided. Many studies found that consumers in Kenya prefer raw milk because of its superior taste and its lower price (Blackmore et al. 2015; SDP 2004).

Ndongo et al. (2015), in a study focusing on milk producers and consumers in Kasarani Constituency in peri-urban Nairobi, found that high-income consumers preferred to buy pasteurized milk as they viewed pasteurization as a guarantee of quality and longer shelf-life, and appreciated the convenience of packaged milk for transport and storage.

When asked about the reasons for engaging in the informal milk market, milk producers, traders and vendors in Kisumu and Eldoret mentioned, among other reasons, that there is a general higher demand for milk in the tow cities. They also noted that there is particularly a higher demand for unpackaged or unprocessed milk as consumers like its taste, composition, pricing, and the fact that it can be purchased in small amounts to fit customers' purchasing power (Alonso et al. 2018).

Bosire et al. (2017) found that annual milk consumption per capita in rural Kenya is about 10 kg higher than the urban consumption rate. This is mainly the result of a higher level of access to milk and the direct/own production and consumption of milk at home. Meanwhile, urban consumption requires consumers to locate and purchase milk products with issues related to retail/outlets access. The authors, however, also found that the average per capita milk consumption in Nairobi was about twice as high as the national average. This trend was associated with urban growth and the higher purchasing power of Nairobi residents compared to those of other urban areas. They also cited better access to milk products, facilitated by the close proximity to milk production areas, and high consumption of unprocessed milk as being key factors in Nairobi's high milk consumption rates.

Grace (2015) indicated that Nairobi households drink most of their milk boiled in tea so there is little health benefit from pasteurization and potentially large health impacts from lowered access to milk because of increased price and the small number of retail outlets that sell pasteurized, chilled milk. However, the introduction of milk dispensers/ ATMs in peri-urban areas which are supposed to offer pasteurized chilled milk with better quality at an affordable competitive price could be the ideal solution in the near future.

In the Smallholder Dairy Project (SDP, 2004), the authors showed that milk price and household income play an important role in consumers' preferences. Low-income consumers have a lower price elasticity (0.12) in absolute values for raw milk (that means an increase of 10% in milk price will decrease milk purchase quantities by 1.2%) and a relatively higher one (0.70; i.e. an increase of 10% in milk price will decrease milk purchase quantities by 7%) for pasteurized milk. For high-income consumers it is the opposite with lower price elasticity for pasteurized milk (0.21) and higher price elasticity (0.93) for raw milk. The same study (SDP, 2004) provides the following reasons for raw milk purchase/preference: it is 20% to 50% cheaper than processed milk, many persons prefer the taste and high butterfat content of unprocessed milk, it is sold in different quantities, is widely accessible and within the reach of many people, and consumers are used to consuming unprocessed milk.

Mwangi et al. (2019) in their study on the satisfaction levels of (370) consumers purchasing processed milk from 15 major supermarket chains in Nairobi, Nakuru, Eldoret and Mombasa towns, found that the majority of respondents indicated that they were able to identify the milk brands they bought by using package and brand colour, and that they were satisfied with the package size of the milk product they purchased. Majority of respondents also expressed satisfaction that the quality of milk products purchased met their expectations, and they trusted the nutritional value of the milk.

Rademaker et al. (2016) indicated that to compete with the lower prices in the raw milk chain, supermarkets such as Tuskys have started to sell raw milk (ACET 2015), showing that retail sales models will change to reflect consumer preferences for raw milk.

Bebe et al. (2018) in their study about milk consumers in Kenya (in Nairobi, Nakuru, Eldoret and Kakamega) found that, overall, price and quality rather than safety are the most important attributes to majority of consumers. For raw milk buyers, price (38%) and quality (31%) are the most important attributes. For packaged milk consumers, quality (34%) and price (25%) are the most important attributes. Quality for fermented milk products (58%) and for milk fat and powder (52%) is the most important attribute. It is interesting to note that the safety attribute was always ranked last, except for fermented milk (second with 17%). The study also found that consumers prefer freshly-processed milk bought from the shops and supermarkets or from the farm directly but buy raw milk from other outlets due to price affordability.

Njarui et al. (2011) in their study of milk and milk products consumption in the semi-arid region of eastern Kenya, found that richer households consumed significantly more milk and milk products than poor households. Raw milk was preferred over pasteurized, UHT and powdered milk because it was cheaper and widely available. Generally, preference for raw milk over other milk products was higher in rural households than in urban households. Consumption of pasteurized milk was skewed toward urban households, with 83% consuming it versus only around 14% for rural households. The authors also found a large disparity in consumption of yoghurt between rural and urban households. About a quarter of the population sampled in rural area consumed yoghurt, compared with 68.5% in urban households.

The authors (Njarui et al., 2011) found that powdered and UHT milk become very popular during the dry season when fluid milk availability is limited. These products can be stored at room temperature without refrigeration and thus are more popular in rural than in urban households.

Research Solutions Africa (2013a), found that the increase in socio-economic class increases spending on processed milk and value-added dairy products, and decreases raw milk consumption. The authors found that when milk was used for cooking, raw milk was prevalent, when used in beverages other than tea, pasteurized milk dominated. The results also indicated that price (84% of respondents), quality (65%), access (58%), quantity (49%) and trusted source (48%) were the main factors influencing raw milk purchase, while price (51%), quality (44%) and brands (44%) were the main factors influencing processed milk purchase. The major barrier to consuming processed milk is affordability (58%), and the fact that processed milk is also perceived to be less nutritious as it is strongly believed that the processing takes away nutrients. A household's choice of fluid milk sources was found to be significantly influenced by the number of children living in the household and education level of the respondent. The more children in household, the more likely the respondent purchased milk from a source that offers quantity, trust and relationships built over time.

Main findings on consumers' choice of milk type and source

For processed/packaged milk consumers, the main factors influencing milk choice are price, aflatoxin-free certification, type of packaging, and fat content.

Milk brand, identified through package size and colour, is another factor influencing consumers choice of processed milk from supermarkets in various Kenyan cities and towns.

For raw milk consumers, the main factors influencing milk choice are price, smell of the milk and aflatoxin-free certification.

In another study (Nairobi and Eldoret), price, smell, hygiene and colour were the main factors influencing consumer choice. Overall packaging is irrelevant, but middle- and high-income consumers prefer milk sold in sealed packaging.

The preference for raw milk versus packaged milk is not very clear in terms of milk quality. Half of respondents think that raw milk is of better quality and the other half believe that packaged/processed milk is of better quality. This 'ambiguity' is also found in scientific studies trying to compare raw milk and processed milk qualities and where the results are not very clear about which product is of better quality and safer.

Price and quality (in inverse order) are the most important attributes for both raw milk consumers and packaged milk consumers, respectively, in Nairobi, Eldoret, Nakuru and Kakamega.

Majority of the studies targeting urban and rural consumers in cities and areas other than Nairobi (Eldoret, Kisumu, northeastern Kenya etc.) found that consumers prefer raw milk because of its better taste, higher butterfat content, lower price, availability, and the fact that it could be bought in different volumes/amounts.

Income affects consumer choice of milk. High-income consumers prefer pasteurized milk linking it to better quality and the convenience of transporting and storing packaged milk.

Rural raw milk consumption is higher compared to the urban raw milk consumption, mainly because of own-production, direct consumption and easy access in rural areas. However, in Nairobi, average per capita milk consumption is higher compared to the national average milk consumption because of the coexistence and availability of both raw and processed milk with a wide range of volumes and prices. Consumption of processed milk and value-added dairy products (yoghurt and fermented milk) is higher in urban areas compared to rural areas.

Affordability (based on household income) and perceptions about lower nutritional qualities are the main barriers to consumption of processed milk by rural and low-income consumers.

Supermarkets such as Tuskys, Naivas and Carrefour are trying to satisfy consumers' preferences for buying bulk milk in customized volumes and at lower prices, by installing milk dispensers' machines known as ATMs. The latter are also found in some milk bars and shops.

Consumers' risk attitudes towards milk safety

Findings from the literature review indicate that Kenyans are generally well aware of the issues related to milk safety and quality. Consumers follow some practises to mitigate these risks. Boiling milk is one of the main measures taken by consumers to ensure milk safety in the country. Walke (2014), Walke et al. (2014), found that almost all (99%) of raw milk consumers boil their milk prior to consumption and 95% of them believe that milk is totally safe after boiling. Health (77%) and hygienic (64%) concerns were the main reasons stated for boiling the milk, followed by 'because everybody is doing it' (21%). The results are similar in the case of processed milk consumers where 79% of respondents indicate that they boil processed milk before its consumption, and that 93% believe milk is totally safe after boiling (Mtimet et al. 2015). The main reasons stated for boiling the milk were health and hygienic concerns (53% and 34%, respectively), followed by the preference of warming the milk up (14%) and 'because everybody does it' (10%).

Consumers are not well informed about the risks of possible milk contamination by aflatoxin and their attitudes vary depending on their level of knowledge of the subject. In fact, Walke et al. (2014) found that 45% of raw milk consumers had never heard about aflatoxin and that only 45% of respondents know that aflatoxin can be transferred to milk from mouldy feed given to a dairy cow. The majority of consumers (69%) perceive aflatoxin in milk as a serious or medium threat to human health, and 85% falsely believe that it is possible to make aflatoxin-contaminated milk safe for human consumption. The extensive boiling of milk or a combination of boiling and refrigerating milk were cited by 75% of respondents as the solution for decontaminating the milk. For processed milk consumers, Mtimet et al. (2015) found that 80% of respondents had previously heard of aflatoxin, and 45% of them knew that aflatoxin could be transferred to milk from cows fed with mouldy feed. The majority of processed milk consumers (87%) perceived aflatoxin as a serious or medium threat to human health. Less than a quarter (23%) of the consumers thought that it was possible to make aflatoxin contaminated milk safe, and 62% of them believed that boiling the milk was the solution.

Trust is another means by which consumers mitigate the risks of consuming non-safe milk. Walke et al. (2014) found that 40% of raw milk consumers knew the farmer who produced the milk and 95% of them fully or mostly trusted the farmer to provide hygienically produced milk. When asked about how much they trust the reseller to provide safe raw milk, almost all respondents showed high levels of trust. In the case of processed milk consumers, Mtimet et al. (2015) found that 75% of respondents knew who had produced the milk and 90% of them fully or mostly trusted the producer/company. In contrast, Fadiga and Makokha (2014), although they did not examine the extent to which trust in the trading partners influences trade volumes along the value chain, found that consumers overwhelmingly claimed not to use trust as an indicator of product quality and safety (for both meat and dairy products). This indicates that at consumer level there is a demand for objective measurements of quality and safety as evidenced by the willingness to pay values for an official stamp (meat) and packaging (milk).

In their study, Fadiga and Makokha (2014) found that a high proportion (63%) of consumers (both in Nairobi and Eldoret) believed the milk purchased was safe for consumption, and 67% said they were willing to pay more for improved milk safety and quality. Low-income consumers, who buy more raw milk compared to other income groups,

systematically boiled the milk before consumption, which minimized consumers' concerns about safety and quality issues.

Ndongo et al. (2015) found that most of the milk in Kasarani (peri-urban Nairobi) was sold directly to consumers, thus minimizing the chance of introducing bacteria during long transportation routes with multiple handlers. The authors also found that most of the milk was normally boiled before consumption which is an effective risk-mitigation strategy.

Bebe (2018) in his study about milk vending machines, consumers' risk perception, and milk quality in five Kenyan towns (Nairobi, Kisumu, Eldoret, Nakuru and Kakamega) consistently found that consumers associated milk vending machines with less risk of adulteration, bacterial load, unhygienic handling and antibiotic residues than they did with the mobile-traded milk. In a random sample, the number of consumers associating milk with high risks were lower for vending machines (<15%) compared to mobile trader milk (between 15-58%), farm supplied milk (between 38–98%) or processed milk (between 12–30%), which according to the author indicates high consumer confidence levels with the quality of milk from vending machines. However, in reality, test results from milk samples indicated that vending machines did not offer better compliance in quality standards over plastic containers (in the informal market) in milk density, solids not fat, hydrogen peroxide, or antibiotics presence. Milk from vending machines performed better than plastic containers in microbiological quality indicators but exceeded Codex standards for aflatoxin (AFM1) contamination 20.87±24.63 ppt). This was not the case for milk from plastic containers.

APRI (2018) in a study about Kenyan consumers' status on food safety (vegetables and milk) undertaken in five counties (Nairobi, Mombasa, Kisumu, Nakuru and Murang'a; sample size of 376 individuals), found that around 79% of respondents were concerned about food safety, 12% were not concerned about food safety while 9% were sometimes concerned. The study found that consumers follow some specific measures to ensure milk safety like boiling milk before use or storage, storing milk in the refrigerator, consuming long-life milk, and using clean containers for milk storage.

Bebe et al. (2018) in their study about milk consumers in Kenya (Nairobi, Nakuru, Eldoret and Kakamega) found that consumers perceived raw milk bought from almost all types of outlets (farm, kiosks, milk bars, mobile traders) to be at a high risk in relation to unhygienic handling, adulteration, bacterial load, and antibiotics. Conversely, consumers were found to perceive raw milk at low risk of containing chemical preservatives. For UHT and fresh packaged milk, consumers' risk perception is only high for the presence of chemical preservatives. The authors also found that, on average, consumers agreed that they think about milk safety when buying and consuming milk (87%), and that it is worth avoiding the risk by buying safety-assured milk at a higher price (75%). Respondents disagreed, however, that buying milk without a safety assurance is worth the risk.

The Research Solutions Africa (2013b) study found that milk consumers prefer buying small volumes of packaged milk (mainly 500 ml) because it seems that keeping an opened package is not popular, indicating consumers' awareness of hygienic risks. Safety risk is considered low by consumers buying raw milk as long as it is obtained from a trusted source (and/or boiled).

Main findings on consumers' risk attitudes towards milk safety

Kenyan consumers are relatively aware and concerned about the issues related to milk safety and quality.

Boiling milk is one of the main milk safety measures taken by the majority of both raw and processed milk consumers who believe that the milk is totally safe after boiling. The use of clean containers for milk storage is another measure taken by consumers. Keeping the milk in the refrigerator for those who have it is another measure stated by the households.

Majority of the studies found that trust in the milk outlet/provider is an important factor/proxy used by consumers, mainly of raw milk, to mitigate product safety issues.

Milk vending machines/ATMs seem to be trustworthy for processed milk consumers in urban and peri-urban areas and are accessible to middle and low-income households.

For a segment of consumers, higher milk price is also an indicator/proxy of product quality and safety, and they are willing to pay for it.

A small proportion of raw milk consumers and a higher proportion of processed milk consumers are aware about aflatoxin contamination and the related health issues. Majority of them think that boiling the milk (extensively) is a solution to aflatoxin contamination.

Consumers' willingness to pay for safe milk

In the economic theory there are various methods employed to assess consumers' willingness to pay (WTP). These methods can be divided into two groups depending on the type of data used: the revealed preference methods and the stated preference methods. The revealed preference methods are based on actual/revealed behaviour of consumers like the travel cost method, hedonic price method etc. Conversely, the stated preference methods are based on what consumers/respondents declare when confronted with a hypothetical situation.

In the case of aflatoxin contamination studies (Walke et al. 2014; Mtimet et al. 2015) the authors used choice experiment to assess consumers' willingness to pay for aflatoxin-free milk. The authors found that both raw and processed milk consumers are willing to pay a premium to buy safe and better-quality milk. Raw milk consumers are willing to pay between KES8–12/litre more for getting white milk compared to yellowish milk. The same consumers are willing to pay a premium price of between KES61– 93/litre to shift from smelly to non-smelly milk, and a premium of between KES58–77/litre to buy certified aflatoxin-free raw milk (Walke et al. 2014). Mtimet et al. (2015) found that processed milk consumers are willing to pay a price premium of KES7/litre to get whole instead of fat-reduced milk. They are also willing to pay a premium of KES18/litre for milk in tetrapack rather than in a pouch, and KES10/litre for a plastic container compared to a pouch. For aflatoxin-free milk, consumers are willing to pay a high premium of KES137/litre which reveals their concern about product safety and health.

When assessing milk consumers WTP for safer and better-quality milk, Fadiga and Makokha (2014) found that consumers were willing to pay a premium for non-smelly (non-odorous) milk, clean milk, and creamy milk, but not for milk in a sealed package. Based on the overall sample, the premium for non-smelly milk (KES 19/litre) was almost three times higher than that for creamy milk (KES7/litre) and two times higher than that for milk produced and sold in a clean environment (KES 8.8/litre). There was a difference between Nairobi and Eldoret regarding the valuation of these attributes. While the estimate of premium for clean milk was similar in both cities, Eldoret consumers were willing to pay KES4/litre more in premium for non-smelly milk, while Nairobi consumers were willing to pay about the same amount more in premium for creamy milk. Moreover, while the estimate of willingness to pay for sealed packaging was not significant for Eldoret, consumers in Nairobi were willing to pay a premium of almost KES3/litre for this attribute. The results indicate that consumers are more willing to pay for safety rather than for quality of milk.

Alonso et al. (2018) in their study of milk producers, traders and retailers in Kisumu and Eldoret towns, found that some traders reported that customers were willing to pay higher prices for better milk in cleaner businesses. Ndambi et al. (2018) in their study of the costs and benefits of implementing a quality-based milk payment system (QBMPS) in Kenya, recommended that consumers should be duly informed about the difference in milk quality that goes through a QBMPS; they may accept a higher price for products generated from it, which could (partly or entirely) compensate the costs borne by the processor.

Wayua et al. (2009) used the experimental auctions technique (revealed preference) in their study of milk consumers (31 respondents) willingness to pay for improved sensory characteristics and/or assurance of milk safety in Moyale town. The authors found that informed older women (age and gender) are willing to pay more for better milk quality in this market when compared with other market participants. Participants in the experimental auction also indicated a general willingness to pay more for additional food safety assurances about milk.

Jerop et al. (2013) assessed consumers' willingness to pay (131 respondents) for dairy goat milk in Siaya County. The authors used the double-bounded dichotomous choice contingent valuation model. Results indicated that consumers were willing to pay an average premium of 38% above the current prevailing price of fresh cow milk. Age, number of years spent in school and number of children present in a household had a positive and significant effect on willingness to pay. Awareness, gender and the number of adults aged between 19 and 59 years present in a household negatively influenced willingness to pay.

Main findings on consumers' willingness to pay for safe milk

Consumers are willing to pay a price premium to get better quality and safer milk. These are stated preferences, and more research is needed to establish whether this would materialize with real purchases. This is especially the case with certified aflatoxin-free milk where the price premiums were found to be very high.

Consumers might be using the smell of milk as a quality indicator and are willing to pay a higher premium for milk that is not smelly and that is produced in a clean environment compared to milk with a bad smell.

Processed milk consumers (mainly in Nairobi) are willing to pay a premium for packaged milk. Their preferences are higher for tetrapack, followed by plastic than for pouch packaging.

Socio-demographic factors like age, gender, education level, and number of children are among the factors influencing consumers' willingness to pay for better quality and safer milk.

Consumers' perception of product labelling

Studies carried out in developed countries have indicated that product labelling matters for consumers who generally carefully read the information provided in the label. In the developing countries, studies that assess consumers' perception of product labelling are few. The number of studies is even lower when it comes to milk and dairy products where, as previously mentioned, the majority of the milk is sold raw in informal markets.

Despite the lack of overall research conducted in this area, some research on milk and dairy has tried to assess consumers' perceptions and opinions about certification, food safety labels, and product labelling in general. Walke et al. (2014), when assessing raw milk consumers' behaviour, found that more than 60% of respondents do not trust or do not look at the certificates and safety labels of milk and dairy products, while more than 35% report trusting these certification and labelling. Only 30% of respondents rely on the information provided on product packaging labels and commercial advertisements. Mtimet et al. (2015) found similar results when assessing processed milk consumers of whom 57% said they do not trust or do not look at the certificates and/or food safety labels of the products, while 43% trust these certifications and labelling. The proportion of consumers who do not rely on the information given on product packaging labels and commercial advertisement is also very high (69%), indicating a lack of trust among consumers that should be seriously considered by the processors, retailers, and the Kenyan government certification agency. However, Wambugu (2014), when assessing customers' attitude towards milk packaging designs in Kenya (1,000 respondents from 3 towns in the Nairobi metropolitan area: Ruiru, Kiambu and Ongata Rongai) found that information on the pack including the expiry date is among the important milk attributes for packaged milk consumers.

Main findings on consumers' perception of product labelling

Few studies in Kenya have focused on milk consumers' perception of product labelling.

The majority (two-third) of raw and processed milk consumers in Kenya do not trust or look at the certificates and safety labels in milk packaging.

There is a lack of consumers' trust on the certifying institutions.

Conclusion and recommendations

From the findings presented in this report, the following conclusions and recommendations can be drawn:

Milk and dairy products form part of the daily diet of Kenyans from all income segments. Milk purchase is mainly done every day, and the product is consumed either as a tea whitener in the morning or as part of the meal during lunch or dinner (especially for low-income consumers and infants). This indicates the important nutritional role of milk and dairy products.

Per capita consumption of milk and dairy products is lower in rural areas compared to urban areas and is much lower than the 'proclaimed' average national consumption of 125 kg/capita. There is therefore room to increase consumption of milk in these areas and the government efforts should aim at achieving this objective. Children's milk intake at school, through programs such as the National School Meals and Nutrition Strategy 2017–2022, could play an important role in increasing milk and dairy products consumption and attracting new and young consumers.

In rural milk production areas, consumers mainly purchase raw milk; while in urban areas and big cities like Nairobi, raw milk and processed milk are both available and purchased by consumers. Overall 'informal' raw milk trading and consumption predominate the market and this trend will probably persist for the next decade. There is therefore need for greater government involvement to support this 'informal' marketing channel in terms of capacity building, sensitization, training on milk handling and hygiene, and certification.

Producers, hawkers/mobile traders, and milk bars are the main suppliers of raw milk to consumers who are mainly located in rural and peri-urban areas, and in production areas. These milk suppliers should be targeted by future government/sector sensitization and capacity building activities.

Low-income households are the largest category of the Kenyan pyramid, which ranks them first in terms of milk volumes consumed compared to the rest of the population (middle- and high-income consumers). Milk choice for this segment is mainly driven by product price due to their limited financial resources/income. 'Forced' shifting from raw (low price) to processed milk (higher price) consumption for this consumer category will decrease the quantities consumed at the household level (adults, children below 18 years, and infants), and will have negative consequences on the nutritional status of household members and child growth and development.

In addition to price, which was cited by majority of consumers as the main factor for purchasing raw milk, product freshness was also mentioned and ranked second. Consumers perceive raw milk as fresher and of better nutritional ingredients compared to processed milk which, from their perception, loses nutritional quality from the heating process. There is, in this case, an important sensitization role that should be done by consumer associations and processors on the nutritional value of processed milk if they want to attract and change the consumption patterns of raw milk consumers.

Both processed and raw milk consumers are relatively aware and concerned about milk safety and quality. There are, however, misconceptions and myths that should be corrected. This work is mainly the role of consumer organizations and the dairy processers who are the most prejudiced by these misconceptions and myths.

Buyers of raw milk mostly rely on sensory characteristics of the milk (smell, colour/appearance, taste, texture) and their knowledge/trust of the milk vendor to assess the quality and safety of milk. The sensory characteristics could be a good first proxy to asses milk quality, but they are not sufficient and can also mislead consumers. Trusting the vendor (majority of raw milk consumers are loyal to a specific vendor/retail outlet) is also an important factor. Both means could be reinforced if these informal vendors/marketing channels are certified (in terms of milk handling after training of relevant actors in the chain) and are subject to at least one random product control per year. The controlling authorities and the Kenya Dairy Board should be involved in these processes and controls.

Higher milk price, processing and packaging are proxies used by processed milk consumers to assess the safety and quality of product. There is, however, no general consensus about the fact that processed milk is safer and of better quality compared to raw milk. This misperception is also found when looking at scientific studies comparing milk quality/composition and pathogens assessment. There is a need for more scientific evidence about this issue. National universities, national and international research centres could be commissioned by the ministry of livestock and the Kenya Dairy Board to undertake such studies.

Boiling milk is the main risk mitigation strategy used by the majority of raw and also processed milk consumers who believe that the milk is totally safe after boiling. Although boiling the milk would kill almost all pathogens, there are other issues related to milk adulteration, antimicrobial resistance, addition of antibiotics or other illegal chemical products to preserve the milk etc. that should be considered. This means that consumers should be sensitized about these other issues, so that they do not take for granted milk safety after boiling.

It seems that consumer practises towards milk consumption and safety have not changed drastically during the last decade. Preferences for raw milk still predominate, boiling milk is still widely practised and considered as the best way of safety assurance. For those who can afford it, shifting to processed milk is another option.

Women are the ones mainly involved in buying milk and dairy products. This was observed in both the low-income and middle- and high-income population. They are also generally the ones involved in preparing the food at home. Any sensitization campaign should consider this aspect and work closely with women.

The purchase of pasteurized milk from vending machines/ATMs is increasing in importance among low and middle-income consumers and might become their preferred source in the near future. There are, however, many safety and quality challenges associated with the milk sold through ATMs: the milk might not be pasteurized, it might be adulterated with water, the internal cleanness of the machine might not be checked frequently and/or adequately undertaken etc. There are also issues related to the cleanness of the bottles brought by the consumers and the time spent between purchasing the milk (generally cold) and its use/consumption by the household. The Kenya Dairy Board with the concerned regulatory authorities should sensitize the owners of these milk ATMs about the importance of hygiene and the continuous cleanness of the machines and should frequently check the quality of the milk. Additional research to assess the quality and safety of milk sold through vending machines is also required.

In general, consumers are aware about the importance of milk safety and the health problems that contaminated milk could present. But there is a lack of understanding of which specific safety and quality issues are related to milk contamination. There is a need to invest in consumer sensitization about these issues.

When asked, consumers are willing (stated preference) to pay a premium for better quality and safer milk. However, the data showing the importance of raw milk purchase (lower price) and also low consumers' purchase power indicate that in reality this might not be feasible. Only middle- and high-income consumers could pay for better quality milk.

From the literature review, only one study was found focusing on milk consumers' trust on certification and labelling. The study findings showed that the majority (two-third) of raw and processed milk consumers in Kenya do not trust or do not even look at the certificates and safety labels. There is also a lack of consumer trust on the certifying institutions. More studies should be commissioned to assess this topic. Consumers' lack of confidence in the certifying institutions is an important issue that should be considered by the government and the private sector.

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