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KENYAN PERCEPTIONS OF AFLATOXIN: AN ANALYSIS OF RAW MILK CONSUMPTION

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Abstract

Aflatoxin is a human health threat concern in many developing countries. This study examines Kenyan milk consumers' behaviour toward aflatoxin by way of choice experiments. Further, willingness to pay for different types of milk and aflatoxin status awareness were assessed. Four attributes were selected to describe milk products: smell, colour, price and aflatoxin-free certification.

Results indicate that awareness of aflatoxin is relatively high, and that consumers are willing to pay a significant premium for milk that is certified as aflatoxin-free. Results also show, however, that the substantial majority does not know how to avoid aflatoxin-contaminated milk. The results indicate a great need for further education and awareness-raising programs throughout the Kenyan dairy value chain, and a potential for market-based solutions to aflatoxin control in milk.

Keywords: Milk consumers, Aflatoxin, Kenya, Best-Worst Analysis, Willingness to Pay

1. Introduction

Aflatoxins are mycotoxins produced by certain species of moulds, mainly *Aspergillus flavus* and *Aspergillus parasiticus*. Aflatoxins are considered an important public health concern in the developing world and can seriously affect people's health and livelihoods. The problem is rooted throughout the food chain, and as freedom of choice in food is limited for a poor and food-insecure population, exposure to aflatoxin is widespread and consumers in developing countries are at risk from aflatoxin-related illnesses. Recent estimates suggest that there are more than five billion people worldwide at risk of chronic exposure to aflatoxins (Williams *et al.*, 2004; WHO, 2005).

Although there are no accurate estimates of incidence of chronic and acute disease related to aflatoxin exposure, outbreaks in Kenya (1982, 2001, 2004 and 2005) and Somalia (1997/98) indicate the magnitude of the problem. The 2004 outbreak in Kenya was responsible for 317 cases and 125 deaths. A known consequence of chronic exposure to aflatoxins is increased risk of liver cancer. Moreover, aflatoxin exposure in young children has been shown to be associated with stunting and underweight (Wang *et al.*, 1996; WHO, 2005). In general, adults have a higher tolerance for aflatoxin than do children, and children are more prone to death from acute aflatoxicosis (Cullen and Newberne, 1994).

Because Kenya´s climate is favorable to the growth of aflatoxin-producing moulds, the country faces high risk of mycotoxin-related livestock and human poisoning (Lanyasunya *et al.*, 2005). Humans are exposed to aflatoxins not only through staple foods such as cereals, but also through animal source food; the most risky food is milk (Jarvis, 2002). Aflatoxins found in milk are produced by lactating animals after they have consumed aflatoxin-contaminated feed or fodder (Lanyasunya *et al.*, 2005; Lizárraga-Paulin, 2011). The most effective means of controlling aflatoxin in milk is therefore by restricting its presence in the cattle´s feed (FAO, 2005). In Kenya,

Feed represents the largest part of the cost of milk production in market-oriented Kenyan dairy farming, and so there is a pronounced incentive for minimizing these costs. There are consequent incentives to feed forage of low quality, and such practices are widely observed (Muriuki, 2011). There are no effective mechanisms to ensure quality in the market for feeds.

The negative impacts of aflatoxins in milk on human health have led to several research projects being focused on the subject. Widespread uptake of information on similar threats to health in Kenya, from various sources, has been documented (USAID, 2010) The consequence should be a dairy industry encouraged to strive for better control of aflatoxins' occurrence in milk. Milk is an important source of animal protein in Kenya. It is of special importance for society's three most nutritionally vulnerable groups: infants, children and pregnant women. Therefore, if exposure could be reduced by inspection and certification controlling the levels of aflatoxins in milk, the overall health of Kenyans could be enhanced, while also reducing health care costs.

In Kenya, traditional as well as modern milk sales channels play important roles in satisfying consumer needs: small-scale milk traders constitute a cost-effective link between consumers and dairy producers. Hence, standards must be realistic for this context, for setting up and administering certification. Introducing licensing of raw milk traders also involves monitoring of milk quality, and so leads to development of the raw milk market. It also requires establishment of a recognized system of accreditation and training. Informal traders in Kenya must be trained in order to be certified and licensed to sell milk (Omore *et al.*, 2005). Theoretically, addition of an aflatoxin- quality assured element to current certification

would support a gradual "formalizing" of raw milk traders´ operations. This implies additional production and handling costs that directly affect milk selling prices.

Understanding consumer behaviour plays a major role in the design of successful interventions in commercial processes. Relevant research has been widely conducted in developing countries for animal products' consumption (e.g. Jabbar *et al.*, 2010). The current study aims to reveal important insights in Kenyans´ milk purchase and consumption behaviour. It also addresses a major public health concern by focusing on aflatoxin. Kenyan raw milk consumers' perceptions of aflatoxin are identified, along with any willingness to pay (WTP) for an aflatoxin-free certificate. Such WTP could encourage dairy stakeholders to invest in credible certification instruments. This paper also identifies the needs of a certification by providing insights into milk consumers´ attitudes.

2. Data collection and methodology

2.1 Data collection

A survey was conducted during July 2013 using face-to-face interviews with consumers/buyers of raw milk on public streets. Data were collected in Dagoretti, one of the eight divisions of Kenya's capital city of Nairobi. Dagoretti division is characterised by high practice of urban agriculture including dairy production and high human and cattle populations (Kang'ethe et al., 2012).

For the selection of respondents, systematic sampling was conducted, pursuant to assumptions of randomness over time. Refusal to participate (an early concern of the authors) was negligible, so systematic bias concerning respondents´ characteristics is unlikely. All categories of consumers were targeted, by way of conducting the survey across different periods of time. This involved collection from Tuesday until Saturday from 9am to 6pm for a 3-week period. Four enumerators established a total sample size of 323 respondents.

The questionnaire contains five sections. The first addresses milk purchase and consumption habits, and so helps depict the respondent´s purchase and consumption behaviour. The second part assesses the respondent´s aflatoxin awareness. Following this, the consumer was given informational text informing about aflatoxins and the risks of aflatoxins in milk especially. This information was needed to complete the subsequent section of the questionnaire which simulates a purchase decision by using a choice experiment. Finally, some questions concerning the respondent´s attitudes and socio-demographic characteristics were asked.

Table 1. Selected raw milk attributes and their corresponding levels

Attributes	Levels
Milk colour	White ; Yellowish
Milk smell	Not smelly ; Smelly
Aflatoxin-free certified shop	Certified retailer ; Non-certified retailer
Milk price (KSH/Litre)	50 ; 60 ; 70 ; 80

To choose the appropriate attributes and their corresponding levels for the choice experiment, relevant literature about raw milk purchase and consumption in developing countries (Waithaka *et al.*, 2002; Omore *et al.*, 2005; Makokha and Mohamadou, 2010) was reviewed. When selecting attributes, it was found that smell and colour are two important criteria used by consumers for assessing raw milk quality. Therefore, both attributes were

included in the choice experiment to define the milk choices. To reflect the milk market´s price level, four levels ranging from 50 KSH to 80 KSH per litre were selected (Table 1).

The combination of the four attributes with their corresponding levels led to a total of 32 (2x2x2x4) hypothetical products. As the questionnaire was supposed to be completed in a reasonable time, the number of choice cards needed to be reduced, and this task employed an orthogonal design procedure. Considering efficiency and orthogonality requirements, without reducing variability, eight choice cards was the minimum feasible number. Each card contained three choices of hypothetical milk products. Respondents were asked to state their most, as well as their least, preferred choice of milk (product) for each card. The resulting choice experiment fulfils the properties of orthogonality, and exhibits a high D-efficiency level (95%). Figure 1 below shows an example of a choice experiment card. This type of experiment is better known as a Best-Worst, or sometimes a Most-Least, experiment.

Card 1

Please indicate the most preferred cow milk and the least preferred cow milk (Tick only one case in each line)

	Milk 1	**Milk 2**	**Milk 3**
	Yellowish	Yellowish	White
	Not smelly	Smelly	Smelly
	Non-certified	Aflatoxin-free certified	Aflatoxin-free certified
	50 KSH/Litre	80 KSH/Litre	70 KSH/Litre
Most preferred	☐	☐	☐
Least preferred	☐	☐	☐

Figure 1. An example of a choice experiment card

Respondents were asked to indicate the most and least preferred products. In the case of this experiment which includes three alternatives, the choice of most and least preferred products makes possible the full classification of the three products. Because the alternatives have no specific label or name, this class of choice experiment is referred to as generic or unlabelled (Louviere *et al.*, 2000).

2.2 Methodology

Conjoint analysis arises from the theory of Lancaster (1966), which stipulates that utility is derived from the properties or characteristics that goods possess (bundle of attributes) rather than the good *per se*. Since its first development during the 1970s (Green and Rao, 1971; Green and Srinivasan, 1978), the conjoint analysis technique has grown in popularity and has been extended to many disciplines such as transportat, telecommunications, the environment, marketing, and human health. In the agrifood sector, various studies used conjoint analysis (choice experiments) to explore consumer behaviour.

Generally, conjoint experiments employ ordered logit (OL) and ordered probit (OP) models to study consumers' preferences in the case of ordered responses; that is, the dependent variable takes ordered discrete values: 1, 2, 3, and so on. In this study the OL model was selected, based on ease of interpretation of the parameter estimates, which are employed in the WTP calculation. In addition, to maximise the degrees of freedom, three alternative models were estimated by considering product cards' ordering as a discrete choice experiment: that is, the first ranked alternative is considered the chosen product. These are the

conditional logit (CL), the rank ordered logit (ROL), and the random parameters logit (RPL, also called the mixed logit). The rationale of using these three models is to obtain more robust and precise estimates, particularly the RPL model which allows for randomness in the attributes' measurement across respondents.

All the abovementioned models rely on the Lancaster assumption regarding overall utility decomposition as well as random utility theory (Manski, 1977). The latter states that overall utility U_{ij} can be expressed as the sum of a systematic (deterministic) component V_{ij}, which is expressed as a function of the attributes presented (raw milk characteristics in this example), and a random stochastic component ε_{ij}:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (1)$$

Lancaster theory leads to the following linear additive decomposition of V_{ij}:

$$V_{ij} = \beta_1 x_{ij1} + \beta_2 x_{ij2} + \ ... + \beta_n x_{ijn} \quad (2)$$

where x_{ijn} is the n^{th} attribute value for card j for consumer i, and β_n represents the coefficients to be estimated. Finally, following additional assumptions about the distribution of the error term, the following probability models could be derived:

CL (McFadden, 1973):

$$\Pr(j) = \frac{e^{V_{ij}}}{\sum_{k \in C_n} e^{V_{ik}}} \quad (3)$$

RPL model (Train, 2009):

$$\Pr(i) = \int \left(\frac{e^{\beta' . x_{ni}}}{\sum_j e^{\beta' . x_{nj}}}\right) . f(\beta) . d\beta \quad (4)$$

where $f(\beta)$ is the density function of β

Based on the aforementioned models, the willingness to pay (for specific attributes) estimates (WTP) are obtained as follows (Haefele and Loomis, 2001):

$$WTP_i = -\frac{\beta_i}{\beta_{price}} \quad (5)$$

In the case of the RPL moidel, a fixed term for the price coefficient and a normal distribution for the random parameters, are imposed.

3. Results and discussion

The following paragraphs present the descriptive statistics for the study, derived using the software STATA (version 13). As per sampling strategy, every respondent is consuming or buying raw milk, and all are Kenyan citizens.

Respondents were asked about their milk purchase habits (Table 2). For the majority, raw milk is the first choice. Only around 5 percent prefer processed milk and opt for raw milk thereafter. Cow milk is consumed by all respondents while other types of milk, like goat and camel milk, play a negligible role.

Women are significantly frequently more often responsible for the household´s milk purchase than are men. The place where people buy their milk varies by area. More than 40

percent normally buy their raw milk in a shop. 25 percent respectively prefer to buy directly at the producer/farmer or at a milk bar. Kiosks (15 percent) and hawkers (ten percent) are the least common buying places. Since people in such regions generally do not have the possibility to refrigerate, more than 90 percent buy milk once or more than once a day in order to ensure freshness.

Table 2. Selected milk purchase sample habits

Characteristic	Definition	%
Milk bought/purchase occasion	0.5 litre	12
	0.6 litre	18
	1.0 litre	38
	2.0 litres	9
Price per litre	40 KSH/litre	12
	50 KSH/litre	21
	60 KSH/litre	20
	65 KSH/litre	14
	70 KSH/litre	14
Place of purchase	Shop	41
	Producer/Farmer	25
	Milk Bar	25
	Kiosk	15
	Hawker	10
Frequency of milk purchase	More than once a day	22
	Once a day	69
	Few times per week	5
	Occasionally	4

Some 60 percent report not knowing who has produced the milk they are buying. The remaining 40 percent, who know the producer, were asked how much they trust the farmer to provide hygienically produced raw milk. Almost 95 percent fully or mostly trust; only five percent do not trust at all. Moreover, all respondents were asked how much they trust the reseller to provide hygienic raw milk. Again, a high percentage fully or mostly trusts the reseller.

There is a price variation among respondents. The most affordable milk cost 30 KSH/litre; the most expensive 95 KSH/litre. However, the range between 40 KSH/litre and 70 KSH/litre reflects the most frequently paid prices. These results also confirm the price levels used in the choice experiment. It is also notable that almost every respondent knew how much milk they recently purchased, as well as how much it cost.

Survey results for consumption habits are presented in table 3. Almost all respondents report boiling milk prior to consumption and more than 95 percent believe milk is totally safe after boiling. Health and hygiene concerns are the main reasons stated for boiling the milk, followed by “because everybody does it”. Almost half of the respondents drink milk on a daily basis where the quantities of 300 ml, 600 ml and 900 ml are the most frequently reported. For consumption by the respondents´ children, infants (two years and younger) were distinguished from children (from three to 18 years of age). In 18 percent of the interviewed persons´ households, there are children younger than three years. Of those children, 67 percent consume milk. Most of the infants receive between 300 ml and one litre per day.

Almost half of the respondents have children aged between three and 18 years in their household. Some 55 percent of those children consume raw milk daily, and another four percent several times per week. There were also a considerable number of infants and children who never or only occasionally consumed milk. A few respondents could not specify the amounts of milk their children consume.

Table 3. Selected milk consumption habits

Characteristic	Definition	%
Boiling milk prior to consumption	Yes	99
	No	1
Milk is safe after boiling	Yes	95
	No	5
Reasons for boiling the milk	Health concerns	77
	Hygienic concerns	64
	No refrigeration	18
	Uncertainty about milk´s freshness	11
	Because everybody is doing it	21
Personal consumption frequency	Daily	43
	Several times per week	5
	Occasionally	31
	Never	21
Own infants´ consumption	Daily	67
Frequency	Several times per week	0
	Occasionally	9
	Never	21
	I don´t know	3
Own children´s consumption	Daily	55
Frequency	Several times per week	4
	Occasionally	18
	Never	8
	I don´t know	15

Table 4 summarizes some of the findings of the aflatoxin awareness testing. These show that 55 percent of respondents had previously heard about aflatoxin. More than half of the people who had heard about aflatoxin believe, or know, that it can be transferred into milk. Some 45 percent had never heard about aflatoxin. Out of that group, 34 percent believe that the toxins can be transferred into milk. Without distinguishing between those two groups, almost half of the 323 respondents believe that aflatoxins in cattle feed can be transferred into the cow´s milk: and these respondents were asked further questions concerning aflatoxins in milk.

Respondents assessed the health impact on humans when consuming contaminated milk. The majority perceive a serious or medium threat. It was also asked if it is possible to make contaminated milk safe for human consumption. In total, 37 percent think that it is, 27 percent think not, and 36 percent do not know if it possible to make the contaminated milk safe. There is no substantial difference in the answers given, between persons that knew about aflatoxin before, and those that did not. Respondents who thought it is possible to make contaminated milk safe for human consumption were also asked how they think this can be done (an open-

ended question). Some 75 percent answered boiling, including extensive boiling and the combination of boiling and refrigeration, with the latter being the most provided answer. This was followed by processing/pasteurizing/purification and treating with chemicals or herbs. Only a very few people said that not feeding contaminated feed ensures safe milk, although this is in fact the most effective means of controlling aflatoxins in milk (FAO, 2005).

Table 4. Selected aflatoxin awareness sample findings

Characteristic	Definition	%
Heard about aflatoxin	Yes	55
	No	45
Aflatoxins can be transferred into milk	Yes	45
	No	14
	Don´t know	41
People who have heard about aflatoxin	Aflatoxin can be transferred	54
	Aflatoxin cannot be transferred	17
	Don´t know if Aflatoxin can be transferred	29
People who have not heard about aflatoxin	Aflatoxin can be transferred	34
	Aflatoxin cannot be transferred	12
	Don´t know if Aflatoxin can be transferred	54
Health impact on humans	Serious threat	53
	Medium threat	19
	Minor threat	10
	No threat at all	3
	I don´t know	15
Possible to make contaminated milk safe	Yes	37
	No	27
	I don´t know	36
Options to make contaminated milk safe	Boiling	75
	Processing/pasteurizing/purification	10
	Treating with chemicals or herbs	9
	Not feeding contaminated feed	6

In addition to assessing the WTP for aflatoxin-free certified milk, it is important to know consumers´ attitude towards information provided by the industry or government, such as labels and certificates which would be the main communicated elements of the certification system. The survey sought respondents´ opinions about food certificates/food safety labels, as well as information given on product packaging labels and commercial advertisements. Results are similar for both of these. However, the perception of certificates and labels is slightly more positive than that of packaging and advertisements. More than 60 percent of respondents stated that they do not trust, or do not even look at, the certificates and labels. In contrast, more than 35 percent report trust in them. Towards information provided on product packaging labels and commercial advertisements, respondents are even more sceptical: less than 30 percent rely on such information.

The survey also assessed milk consumers´ main sources of information for staying current. Multiple answers were allowed and the results are consistent with those achieved by

USAID in 2010. Television is the most popular one, stated by more than 80 percent. This is followed by radio, newspaper and internet. Consequently, TV and radio are the most efficient channels to inform people in peri-urban areas. As outlined above, these communication means are available to organizations in order to spread information, for example about health threats and new products.

As discussed, we used two models (CL and RPL) to analyse the importance of raw milk attributes and evaluate consumers' willingness to pay (WTP) for milk attributes. The log likelihood ratio test (LL) indicates the two models´ overall significance. The obtained results (table 5) for both models feature the same coefficients´ signs and pattern of significance. All the variables are significant at a 1% level of test, in each model.

Table 5. Estimated CL and RPL models' coefficients

Variable	CL	RPL
	Coefficient	Coefficient
White[a]	.0.3567***	.3732***
	(.0672)	(.1026)
Smelly[b]	-1.8465***	-4.3353***
	(.1000)	(.3218)
Certified[c]	1.7593***	3.5811***
	(.0705)	(0.2525)
Price	-.0301***	-.0465***
	(.0029)	(.0043)
SD_White		.9222***
		(.1636)
SD_Smelly		3.3155***
		(.2869)
SD_Certified		2.9298***
		(.2254)
LL	-1980.1***	-1683.6***
Pseudo R^2	0.1998	

[a] Dummy variable takes 1 when the milk is white and 0 when it is yellowish.

[b] Dummy variable takes 1 when the milk is smelly and 0 when it is not smelly.

[c] Dummy variable takes 1 when the milk is certified and 0 when it is non-certified.

***Significant at 1%.

Results from Table 5 indicate that consumers prefer white milk to yellowish milk. As expected, smelly milk is less preferred than is non-smelly milk and respondents prefer to buy milk from certified retailers. The negative price coefficient estimate indicates that lower prices are preferred to higher prices, which is consistent with conventional demand theory. In the case of the RPL model, the random coefficients are all significant at the 1% level. This indicates the heterogeneity of respondents' attribute preferences.

The second step in the analysis was to estimate consumers' willingness to pay (WTP) following equation 5. Table 6 summarizes the WTP estimates and 95% confidence intervals

obtained following the Krinsky and Robb (1986) parametric bootstrapping procedure with 2,000 replications.

Although the majority of respondents stated that they fully or mostly trust in the hygienic milk handling of farmers and retailers, results indicate that they would be willing to pay a premium for improved quality. Those results agree with those of previous studies such as USAID (2010) and Jabbar *et al.* (2010) which found that the majority is willing to pay a premium for enhanced quality for raw milk due to the uncertainty about the milk´s authenticity and the unhygienic handling conditions.

The WTP estimates obtained with CL and RPL differ. This was expected since for the latter model, consumers' preference heterogeneity is taken into account.

Table 6. Willingness to pay (WTP) estimates and 95% confidence intervals (CI)

Model	White		Smelly		Certified	
	WTP (KSH/l)	95% CI	WTP (KSH/l)	95% CI	WTP (KSH/l)	95% CI
CL	11.8	[7.3; 16.8]	-61.2	[-71.6; -53.4]	58.4	[50.0; 69.6]
RPL	8.0	[3.6; 12.8]	-93.3	[-110.9; -79.1]	77.0	[64.3; 93.9]

On average consumers are willing to pay between 8 and 12 KSH/litre more for getting white milk compared to yellowish. This could be considered as surprising because white milk may indicate dilution with water. However, for milk buyers, the white colour could be an indicator of the hygienic quality of the product.

Since smell is one of the most important attributes to assess the quality of raw milk (Omore *et al.*, 2005; Lapar *et al.*, 2010; Makokha and Fadiga, 2010), consumers are willing to pay between 61 and 93 KSH/litre more to shift from smelly to non-smelly milk. The extra amount they are willing to pay in order to buy from an aflatoxin-free certified retailer is on average between 58 and 77 KSH/litre. These last two WTP estimates show that there is a high interest among the Kenyan peri-urban population in purchasing milk that is harmless to health. At the same time, a notable result is that these consumers are willing to pay more for non-smelly milk than for an aflatoxin-free certified product, *ceteris paribus*.

The results are of value to the dairy industry in the design and implementation of the necessary actions to improve the quality of the product and provide consumers with aflatoxin-free and safe product. The obtained WTP estimates, although consistent in sign across models, are slightly high. These estimates should be interpreted in context. First, providing respondents with information on aflatoxin increases respondents' awareness and may bias WTP estimates. Second, stated preference methods generally face the problem of response bias since it is impossible to simulate precisely a purchase decision. As a consequence, in many cases estimates of WTP are higher than what consumers will really spend. However, especially when testing for a new or unknown product, there are no other available options.

4. Conclusion and implications

This study reveals important insights into Kenyans´ attitudes and behaviour regarding milk and its consumption.

The results show that consumers in peri-urban areas are willing to pay a premium for buying the milk from a certified retailer. However, since people prefer raw milk because of its

low price (USAID, 2010; Makokha and Fadiga, 2010), it remains questionable if they would still be willing to pay more once they would have the choice. Many researchers have recommended lowering the milk prices in order to encourage more people to buy milk (USAID, 2010). However, in the context of aflatoxin, the question arises as to whether it is better to drink a recommended amount of milk at a low price, or rather focus on the quality of milk even if such attributes of safety are available only at higher prices. Although further research is needed on the subject, this study confirms others' (USAID, 2010) findings that quality improvements are desired by a high percentage, and that an aflatoxin-free certificate would be in demand.

The survey revealed that the majority of Kenyans does not trust certificates and labels. As this result contradicts some other findings in similar contexts (Jabbar et al., 2010), the need for further research is apparent, possibly on steps to improve the image of Kenyan certification. Certification requires credibility and intense public information, as well as institutional development. Although the current study does not address these issues directly, its findings of significant WTP suggest that there is sufficient private incentive for change to occur. Hence, its results can be used to put further pressure on stakeholders in the milk value chain to tackle the challenging objective of establishing an independent certification setup that will be accepted and trusted.

As processors are aware that milk of high quality leads to increased sales (USAID, 2010), there can be expected to be interest in enhancing their products by certifying them. Launching a certificate involves cost which would be incident to some extent on milk consumers. Therefore, people need to understand why there is a need to pay more for milk. The study shows that people have insufficient knowledge about aflatoxin and its associated health risks in milk. Research results such as these can then provide the latest and most relevant information which, in association with dairy industry advertisements and brands, can have a high impact on Kenyans and their perceptions. This advocates for partnership amongst researchers, government and the private sector, for further research into the topics covered here, and for further examination of experimental methods and analytical approaches.

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