***Original Research Article***

**Knowledge levels of vendors and consumers on acrylamide in selected foods vended in informal settlements of Nairobi, Kenya**

**ABSTRACT**

**Aims:** To establish the levels of knowledge of vendors and consumers on acrylamide in selected foods vended in informal settlements.

**Study design**: Cross-sectional study design.

**Place and Duration of Study:** Kibera Informal settlements, Nairobi City County, May 2021.

**Methodology:** Sample: The study participants were a total of 632. These included 248 vendors (66 males and 182 females) and 384 consumers (163 males and 221 females) of selected foods (potato chips, crisps, bhajia, chapatti, mandazi, samosa and coffee). They were aged 18 years and above. Sampling techniques: Purposive sampling was used to select the County, random sampling for the villages and convenience sampling for the respondents. Data collection tool: Researcher administered questionnaire which included a Likert scale for knowledge measurement. Data analysis: SPSS version 20 was used for data entry and analysis. Knowledge was measured in terms of mean percentage scores and categorized in levels. Pearson’s chi square tests were done to check for the necessary associations.

**Results:** Most (73.3% vendors and 57.6% consumers)of the respondents were females. Among the vendors, the largest proportion (34.1%) was aged 25-34 years while among the consumers, most (60.8%) were aged between 18-34 years**.** The largest proportion (47.2% vendors and 49.1% consumers) had attained secondary education. Most (72.2%) of the vendors and most (63.5%) of the consumers had poor knowledge on acrylamide. The mean knowledge of both the vendors and the consumers was poor at 25.8% and 27.2%, respectively. Pearson’s chi square test showed statistically significant association between knowledge levels and the perception of acrylamide as a human health concern by the respondents; vendors (*P*= .001) and consumers (*P*= .001).

**Conclusion:** The mean knowledge level for the respondents on acrylamide was poor. Hence, there’s need to hold regular educational campaigns targeted at vendors and consumers of acrylamide forming foods on acrylamide formation, mitigation and health risks associated with exposure to it. The educational campaigns should be clearly set out in food safety policies.

*Keywords:**Acrylamide, acrylamide formation, Maillard reaction, Plant-based, Vendors, Consumers, Knowledge levels*

**INTRODUCTION**

Acrylamide is a colorless and odorless substance classified as a genotoxin and a Group 2A carcinogen (IARC, 1994; Favinha *et al.,* 2020). It is a compound that has been used over the years in textile industries, paper making, and cosmetics and as a flocculant in water treatment. Workers in such industries who are exposed to high levels of acrylamide are at risk of its adverse health effects (Borda and Alexe, 2011; Ubaoji and Orji, 2016). Acrylamide is a potential carcinogen, genotoxin and a neurotoxin to anyone exposed to it (Adani *et al*., 2020; EFSA, 2015; Murkovic, 2019; Ubaoji and Orji, 2016). These health issues contribute largely to the disease burden in the world (WHO, 2020).

In food, acrylamide forms naturally when reducing sugars react with an amino acid, asparagine, in a chemical process known as the Maillard reaction (EFSA, 2015; Hamzalıoglu *et al.,* 2019; Murkovic, 2019). It is primarily synthesized when such food is prepared under temperatures above 120o Celsius with minimal moisture (FDA, 2016). High heat cooking methods include frying, roasting, grilling or baking. Typically cooking processes such as steaming and boiling do not lead to acrylamide formation (Adani *et al*., 2020). In a Spanish household study on acrylamide formation prevention, households upheld most of the mitigation measures recommended for the mitigation of acrylamide formation when preparing chips. However, about 81% of the households were not aware of the recommended maximum temperature of 175oC for prevention of acrylamide formation during cooking (EC, 2017/2158/EU; Mesias *et al.,* 2020). According to Constantinides *et al.* (2021), knowledge is one of the key factors that influence food related decisions of individuals. Based on understanding of certain food aspects, consumers decide on the foods to buy and consume and also on which sources to buy from.

In developing countries, awareness on health risks associated with acrylamide exposure is very low (Rifai and Saleh, 2020). In Kenya, from the limited data on acrylamide, little is known about acrylamide in food by both the vendors and the consumers (Mainya *et al.,* 2020). Regardless, in Nairobi informal settlements, potato fried products such as crisps and chips and wheat- based products (chapatti, mandazi and related products) cooked under high temperatures are among the most vended cooked food (Owuor *et al.,* 2017). These food items, including coffee, are the major contributors of dietary acrylamide. Therefore, there is a major gap in dietary acrylamide knowledge regarding occurrence, health risk and its reduction. The study sought to establish the knowledge of vendors and consumers on acrylamide in selected plant-based foods associated with acrylamide. Though not among the most commonly consumed foods in the area, coffee was included in the study for being one of the major contributors of dietary acrylamide.

**MATERIALS AND METHODS**

The study design used was cross-sectional which is important in gathering data from participants at a point in time (Mugenda & Mugenda 2003; Schmidt & Brown, 2021). It was relevant in collecting data on knowledge of vendors and consumers on acrylamide.

The study was conducted in Kibera informal settlements in Nairobi City County. It lies within geographical coordinates 1o19’0” South and 36o47’0” East. About two thirds (60%) of the population of Nairobi city county resides in informal settlements. The study area was selected because Kibera is the largest informal settlement in Kenya (UN-HABITAT, 2020).

In this study, convenience sampling was used to collect primary data. This was after purposive sampling and simple random sampling were used to select the study areas. It was done sequentially across four levels of hierarchy. To improve representativeness, data was collected by using twelve research assistants collecting data at different locations, on different days and at different times of the day (Stratton, 2021). The respondents included a total of 248 adult vendors and 384 adult consumers. The questionnaire included demographic profile of respondents and questions on knowledge on acrylamide among others.

Respondents were asked 5 (five) points-likert scale (strongly agree-5 points, Agree- 4 points, No opinion- 3 points, Disagree- 2 points and strongly disagree- 1 point) questions to estimate knowledge levels of respondents on acrylamide. The knowledge questions were 12 (twelve) in number. Knowledge categories included poor (0-50% score), intermediate (51-70% score) and high (71-100% score) (Yusof *et al*., 2014).

All the collected data was entered and analyzed using the IBM SPSS (Statistical Package for Social Sciences) software version 20. Pearson’s chi square tests at 5% significance level (α= 0.05) were done to check for association between various variables.

**RESULTS**

**Profile of the respondents**

Majority (73.3% vendors and 57.6% consumers) of the respondents were females. Among the vendors, the largest proportion (34.1%) was aged 25-34 years followed closely at 33.3% by the age group between 35-44 years. The highest proportion (47.2%) had attained secondary education while the least (1.2%) had no formal education. Apart from the food vending business, 65% of the vendors were self-employed in a different business whereas the least (0.8%) had formal employment by the government. Most (63%) of the vendors were married while the least (1.6%) were divorced or separated. Approximately eighty percent (80.2%) earned a monthly income of less than 10,000 Kenyan shillings and the least (2.8%) earned between 20,000 and 100,000 Kenyan shillings.

Among the consumers, the most (60.8%) were aged between 18-34 years. Like the vendors, the largest proportion (49.1%) had attained secondary education while the least (2.6%) had no formal education. The highest proportion (31.6%) was self-employed and the least (5%) had formal employment by the government. Approximately 50.6% were married while the least (1.3%) were divorced. Most (78%) earned below 10,000 Kenyan shillings per month and the least (4.7%) had a monthly income of between 20,000 and 100,000 Kenyan shillings.

## Levels of knowledge of vendors and consumers on acrylamide and health risk perception

Individual knowledge levels of vendor respondents varied and were categorized accordingly (Table 1) based on knowledge level categories as outlined by Yusof *et al*. (2014). Most (72.2%) of the vendors had poor knowledge on acrylamide followed by those with intermediate knowledge level (25.8%) while the least (2%) had high knowledge. The mean knowledge of vendors was 25.8% (poor). This was obtained by summing all individual knowledge scores and dividing by the total number of vendor respondents.

##### **Table 1. Knowledge level categories of vendors on acrylamide in food**

|  |  |  |  |
| --- | --- | --- | --- |
| **Knowledge category** | **Frequency (n= 248)** | **Percentage**  | **Mean knowledge level** |
| Poor | 179 | 72.2 | Poor (25.8%) |
| Intermediate | 64 | 25.8 |
| High | 5 | 2% |

Individual knowledge levels of consumer respondents also varied and were categorized accordingly (Table 2). Most (63.5%) of the consumers had poor knowledge on acrylamide, 36.2% had intermediate knowledge while the least (0.3%) had high knowledge. The mean knowledge level was 27.2% (poor). This was obtained by summing all individual knowledge scores and dividing by the total number of consumer respondents.

##### **Table 2. Knowledge level categories of consumers on acrylamide in food**

|  |  |  |  |
| --- | --- | --- | --- |
| **Knowledge category** | **Frequency (n= 356)** | **Percentage**  | **Mean knowledge level** |
| Poor | 226 | 63.5 | Poor (27.2%) |
| Intermediate | 129 | 36.2 |
| High | 1 | 0.3 |

Pearson’s chi square test was done to check for association between knowledge levels and the perception of acrylamide as a human health concern by the respondents (Table 3 and Table 4).

**Table 3. Association between knowledge levels and acrylamide perception as a health concern among vendors**

|  |  |
| --- | --- |
| **Variable**  | **Perceive Acrylamide as a human health concern** |
| **Vendors (n =245)** |
| **Yes**  | **No** | **Significance** |
| **Knowledge** Good (score 51-100%)Poor (score 0-50%) | 60(88.2%)70(39.5%) | 8(11.8%)107(60.5%) | **χ2=46.756, df=1, p=0.001** |

Most of the vendors (88.2%) who had good knowledge (51-100% score) on acrylamide perceived acrylamide to be a human health concern as compared to their counterparts with poor knowledge (0-50% score). In addition, Pearson’s chi square test showed a statistically significant association between knowledge levels and the perception of acrylamide as a human health concern; vendors (*P*= .001). This implies that knowledge plays a critical role in health risk perception which in turn influences practice.

**Table 4.** **Association between knowledge levels and acrylamide perception as a health concern among consumers**

|  |  |
| --- | --- |
| **Variable**  | **Perceive Acrylamide as a human health concern**  |
| **Consumers (n =350)** |
| **Yes** | **No** | **Significance** |
| **Knowledge** Good (score 51-100%)Poor (score 0-50%) | 124(95.4%)91(41.4%) | 6(4.6%)129(58.6%) | **χ2=100.644, df=1,** **p=0.001** |

Like the vendors, most of the consumers (95.4%) who had good knowledge (51-100% score) on acrylamide perceived acrylamide to be a human health concern as compared to their fellows with poor knowledge (0-50% score). Furthermore, Pearson’s chi square test showed a statistically significant association between knowledge levels and the perception of acrylamide as a human health concern; consumers (*P*= .001). These results emphasize the significant role of knowledge in making health choices in life.

**DISCUSSION**

As reported, the mean knowledge of both the vendors and consumers on acrylamide was poor. This is consistent with the results reported by Mainya *et al.* (2020). The result also agrees with the results of a study conducted among medical students in Poland where only 7% reported that they had heard about acrylamide but not even one of them had knowledge on how it is formed (Kowalska *et al.,* 2017).

Though the mean knowledge level was poor for both the vendors and the consumers, the consumers were more (at 27.2%) knowledgeable as compared with vendors (at 25.8%). This result is consistent with the result of GAIN (2020) which found that consumers were more knowledgeable regarding food safety as compared to vendors. With regards to awareness on acrylamide, a systematic review by Perera *et al.* (2021) concluded that there is need to increase community awareness regarding acrylamide. Kowalska *et al.* (2017) also cited the need to educate people on acrylamide and teach them on how to reduce its intake. The poor knowledge among both the consumers and vendors reported by this current study may also be related to lack of public education and sensitization on acrylamide and other food contaminants. In a study by Almomani et al. (2020), a health education intervention had a positive impact on knowledge on chronic non-communicable diseases. Topic-specific education effectively improved the knowledge of students on health promoting behaviours. Regardless of the setting, this study underscores the importance of education on improving knowledge. This is consistent with studies by Romli et al. (2020) and Carpena (2024).

More consumers as compared to vendors perceived acrylamide as a human health concern. This is in line with the finding on knowledge where though both the vendors and consumers had poor knowledge on acrylamide, the consumers were more knowledgeable as compared to the vendors. This result is corroborated by the result of GAIN (2020) which found that consumers were more knowledgeable regarding food safety as compared to vendors. This finding may be explained by the finding that more (73%) consumers had attained at least secondary school education as compared to the vendors (58%) hence the ability to grasp concepts much more easily.

Results also showed a statistically significant association between knowledge and perception of acrylamide as a health concern. Those who had good knowledge perceived acrylamide as a health concern as compared to respondents (vendors and consumers) with poor knowledge. According to GAIN (2020), in their systematic review, socio-demographic characteristics namely age, gender, and education seemed to be associated with food safety knowledge. Sverdlik (2017) also noted that those in upper middle-income categories had better knowledge on food safety as compared to those in low middle income category. In a household study on acrylamide formation prevention, about 81% of the households were not aware of the recommended maximum temperature of 175oC for prevention of acrylamide formation during cooking for French fries (EC, 2017/2158/EU; Mesias *et al.,* 2020). In developing countries, awareness on health risks associated with acrylamide exposure is very low (Rifai and Saleh, 2020).

The finding that knowledge is statistically associated with health risk perception is also consistent with a study conducted in Cambodia on risk perception and dietary decisions. The study concluded that risk perception is a key driver to changing food purchasing and consumption behaviours (Brown *et al.*, 2022). Rembischevski and Caldas (2020) also noted that knowledge had some impact on risk perception. All this points to the importance of good knowledge in making key choices with regards to food and other health matters. According to Constantinides *et al*. (2021), knowledge largely affects decision making. Several principles should be applied to minimize acrylamide exposure in food. They include not cooking food for too long, not cooking food at too high temperatures and giving information on healthy eating which includes eating a balanced and mixed diet, and consuming fried foods in moderation (FAO/WHO, 2011).

**CONCLUSION**

Consumers seemed to have more knowledge on acrylamide as compared to vendors. However, the mean knowledge for both the vendors and the respondents was poor with the mean knowledge level of vendors at 25.8% score and that of consumers at 27.2% score. Hence, the public health sector should educate vendors and consumers on acrylamide formation, mitigation and health risks associated with its consumption. Education increases knowledge and knowledge in turn affects practice and finally good health.

**CONSENT**

All authors declare that ‘written informed consent was obtained from the study participants to be part of this study. A copy of the consent form is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

**ETHICAL APPROVAL**

All authors herewith declare that the study was approved by Kenyatta University Ethics Review Committee.

Disclaimer (Artificial intelligence): Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**REFERENCES**

1. **International Agency for Research on Cancer [IARC] (1994).** Some Industrial Chemicals. Acrylamide. *IARC* *monographs on the evaluation of carcinogenic risk to humans*, 60, 387-433.

## Favinha, A. G., Barreiro, D. S., Martins, J. N., O’Toole, P. & Pauleta, S. R. (2020). Acrylamide-hemoglobin adduct: A spectroscopic study. [*Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*](https://www.sciencedirect.com/science/journal/13861425), 241

1. **Borda, D. and Alexe P. (2011)**. Acrylamide levels in food. *Romanian Journal of Food Science*, 1(1), 3-15
2. **Ubaoji, K.** **I. & Orji, V. U. (2016**). A review on acrylamide in foods:
sources and implications to health. *Mgbakoigba, Journal of African Studies* 6 (1).
3. **Adani, G., Filippini, T., Wise, L. A., Halldorsson, T. I., Blaha, L. & Vinceti, M. (2020).** Dietary Intake of Acrylamide and Risk of Breast, Endometrial, and Ovarian Cancers: A Systematic Review and Dose–Response Meta-analysis. *Cancer Epidemiology, Biomarkers & Prevention,* 29, 1095–106
4. **EFSA CONTAM Panel (2015).** Scientific opinion on acrylamide in food. *EFSA Journal*, 13 (6), 4104
5. **Murkovic, M., Pedreschi, F. & Ciesarova, Z. (2019).** Process Contaminants: A Review. In: Melton L, Shahidi F, Varelis P, (eds), *Encyclopedia of food chemistry* (500-24). Oxford: Academic Press,
6. **World Health Organization (2020).** Noncommunicable diseases. <https://www.who.int/health-topics/noncommunicable-diseases>
7. **Hamzalıoglu, A., Atac, B.¸ Mogol, & Go¨kmen, V. (2019).** Acrylamide: An Overview of the Chemistry and Occurrence in Foods. In: Melton L, Shahidi F, Varelis P, (eds), *Encyclopedia of food chemistry* (pp.492–499). Oxford: Academic Press,
8. **Food and Drugs Association (2016).** Guidance for Industry: Acrylamide in Foods. https://www.fda.gov/Food/FoodborneIllnessContaminants/ChemicalContaminants/ ucm2006782.htm
9. **European Commission (2017).** Commission Regulation (EU) 2017/2158 of 20 November 2017 Establishing Mitigation Measures and Benchmark Levels for the Reduction of the Presence of Acrylamide in Food. European Commission, Brussels.
10. **Mesias, M., Delgado-Andrade, C. & Morales, F. J. (2020).** Are Household Potato Frying Habits Suitable for Preventing Acrylamide Exposure? *Foods*, 9 (6), 799. Doi:10.3390/foods9060799
11. Constantinides, S., Bhandari, S. R., Kenney, E., Frongillo, E. A., & Blake, C. E. (2021). Perspectives on Food Safety and Their Influence on Food Choice in Low- and Middle-Income Countries. *Current Developments in Nutrition*, *5*, 550. <https://doi.org/10.1093/cdn/nzab043_002>.
12. **Rifai, L. & Saleh, F. A. (2020).** A Review on Acrylamide in Food: Occurrence, Toxicity, and Mitigation Strategies. *International journal of toxicology*, *39*(2), 93–102.
13. **Mainya, N. O., Kituyi, L., Wanjau, T. & Okemwa, E. (2020).** Analysis of Tuber Maturity on Levels of Acrylamide in Selected Solanum Tuberosum Products (Chips and Crisps). *International Journal of Scientific and Research Publications*, 10 (5), 988-991.
14. **Owuor, S., Brown, A., Crush, J., Frayne, B. & Wagner, J. (2017).** The Urban Food System of Nairobi, Kenya (rep., pp. i-71). Waterloo, ON: Hungry Cities Partnership. Hungry Cities Report, No. 6.
15. **Mugenda, O. & Mugenda, A. (2003).** Research methods quantitative and qualitative approaches. Nairobi: Act Press.
16. **Schmidt, & Brown, J. M. (2021).** *Evidence-Based Practice for Nurses*. Jones & Bartlett Learning.
17. **UN-HABITAT (2020).** Informal settlements vulnerability mapping in Kenya. The case of Kibera.
18. **Stratton, S. (2021).** Population Research: Convenience Sampling Strategies. *Prehospital and Disaster Medicine,* *36*(4), 373-374. Doi:10.1017/S1049023X21000649
19. **Yusof, A., Chia, Y. C. & Mohd, H. Y. (2014).** Awareness and Prevalence of Mammography Screening and its Predictors - A Cross-Sectional Study in a Primary Care Clinic in Malaysia. *Asian Pacific journal of cancer prevention,* 15(19), 8095-9.
20. **Kowalska, M., Żbikowska, A., Onacik-Gür, S. & Kowalska, D. (2017).** Acrylamide in food products – eating habits and consumer awareness among Medical School students, *Annals of Agricultural and Environmental Medicine*, 24(4), 570–574.
21. **GAIN (2020).** Global review of "Consumer and Vendor Perspectives on Food Safety." A USAID EatSafe Report.
22. **Perera, D. N., Hewavitharana, G. G. & Navaratne S. B. (2021).** Comprehensive Study on the Acrylamide Content of High Thermally Processed Foods, *BioMed Research International*, Article ID 6258508, <https://doi.org/10.1155/2021/6258508>
23. Almomani, M. H., Rababa, M., Alzoubi, F., Alnuaimi, K., Alnatour, A., & Ali, R. A. (2020). Effects of a health education intervention on knowledge and attitudes towards chronic non-communicable diseases among undergraduate students in Jordan. *Nursing open*, *8*(1), 333–342. <https://doi.org/10.1002/nop2.634>
24. Romli, R., Shahabudin, S. , Saddki, N. and Mokhtar, N. (2020). Effectiveness of a Health Education Program to Improve Knowledge and Attitude Towards Cervical Cancer and Pap Smear: A Controlled Community Trial in Malaysia. *Asian Pacific Journal of Cancer Prevention*, *21*(3), 853-859. doi: 10.31557/APJCP.2020.21.3.853
25. Carpena, F. (2024). Entertainment-Education for Better Health: Insights from a Field Experiment in India. *The Journal of Development Studies*, *60*(5), 745–762. https://doi.org/10.1080/00220388.2024.2312832
26. **Sverdlik, A. (2017).** Promoting food security, safe food trading, and vendors' livelihoods in informal settlements: Lessons from Nairobi. Urban Zoo Policy Brief. London, UK: University College London.
27. **Brown, S. M., Nguyen-Viet, H., Grace, D., Ty, C., Samkol, P., H, S., Pov, S., & Young, M. F. (2022).** Understanding how food safety risk perception influences dietary decision making among women in Phenom Phnom Penh, Cambodia: a qualitative study. *BMJ Open*, *12*(3), e054940. <https://doi.org/10.1136/bmjopen-2021-054940>.
28. **Rembischevski, P., & Caldas, E. D. (2020).** Risk perception related to food. *Food Science and Technology*, *40*(4), 779–785. <https://doi.org/10.1590/fst.28219>.
29. FAO/WHO (Joint FAO/WHO Expert Committee on Food Additives) (2011). Evaluation of certain Food Contaminants. Seventy-second report of the Joint FAO/WHO Expert Committee on Food Additives (Rome, 16–25 February 2010). WHO Technical Reports Series 959.