**Methods**

**Grant number:** ES/T008121

**Sponsor:** UKRI

**Project title:** Water & Waste: Expanding safe water and waste management services access to off-grid urban populations in Africa

**Data set:** Market Survey of Food and Beverage Purchase Behaviours, Commodity Packaging and Plastics in off-grid Greater Accra, Ghana and Kisumu, Kenya

**Version** 1, completed Nov 2023

## ****Objectives****

The main aim of this study was to quantify the types of packaging used with commonly purchased foods and beverages in off-grid neighbourhoods of Greater Accra and Kisumu. Sub-objectives included:

* To evaluate the extent to which the ban on plastic carrier bags in Kenya has reduced plastic bag use by consumers
* To assess the extent of labelling of plastics for different commodities and between the two cities
* To develop a low-cost method for identifying plastic resin type, based on simple observations of packaging samples (e.g. whether they float; their behaviour on cutting), as opposed to more complex laboratory techniques. This included assessment of inter-observer agreement when characterising plastic packaging.
* To provide data on packaging for foods and beverages that could be used in conjunction with national household expenditure surveys (e.g. the Ghana Living Standards Survey and Kenya Integrated Household Budget Survey) to characterise domestic solid waste generation.

## ****Study site****

Fieldwork took place in Greater Accra and Kisumu in Ghana and Kenya, respectively, because of their contrasting policies regulating domestic plastic waste generation. Ghana has an extensive sachet (bagged) water industry (Stoler 2012) and raises excise duty on semi-finished and raw plastics but has not banned single-use plastics (Adam et al. 2020). In contrast, Kenya has banned single-use plastic bags since 2017 (Behuria 2021). Kisumu is Kenya's third largest city, with a population of over 500,000, and is located by Lake Victoria. Over 60% of its population lives in informal settlements, typically densely populated and lacking adequate access to electricity, water and sanitation services (Sibanda et al. 2017). In 2015, its population generated an estimated 200 to 450 tonnes/day of household solid waste, mainly organic waste (Gutberlet et al. 2016). Urban Greater Accra region's population was 5.0 million in 2021 (Ghana Statistical Services 2021), with 51% of its households having solid waste collected in 2010 (Ghana Statistical Services 2013). Slum mapping identified 78 slum communities within the city in 2000, though their distribution has subsequently changed (Engstrom et al. 2015). The city of Accra, within Greater Accra region, generates an estimated 0.74kg/person/day of solid domestic waste or 1552 tonnes/day in total (Miezah et al. 2015).

## Study and sample design

30 and 32 Enumeration Areas (EAs) were randomly selected in each city using probability-proportional-to-size sampling, drawing on 2010 and 2009 EA delineations for the Greater Accra region and Kisumu County, respectively. This EA sample size was chosen to reflect the number of urban EAs selected in Greater Accra region and the former Nyanza province in the Ghana Living Standards Survey 7 (Ghana Statistical Services 2018) and Kenya Integrated Household Budget Survey (Kenya National Bureau of Statistics 2018) respectively. This reflected the current study and these surveys sharing broadly common objectives relating to the regional characterization of household consumption. Eligible EAS constituted those classified as urban by national statistical agencies.  Within Greater Accra, they also met one or more of the UN-Habitat criteria for a slum (UN-Habitat 2016) or lacked waste management services, given the project's focus on waste.  Specifically, most households in eligible EAs lived in over-crowded or non-durable housing and lacked improved sanitation or water sources, secure tenure, or waste services.  EAs dominated by communal establishments were also excluded. No equivalent small area census statistics were available in Kisumu, so all urban EAs were eligible.  Given that EA boundaries were delineated a decade or more before planned fieldwork, to allow for the replacement of EAs that no longer met the inclusion criteria, 50 EAs in Kisumu and 70 in Greater Accra were initially selected at random from the eligible EAs.

Project field teams carried out an intensive one-month reconnaissance exercise in all selected EAs, firstly to verify whether they still met one or more of the slum criteria described above, and secondly to enable the teams to overcome the navigational difficulties of identifying EA boundaries in the field. During this exercise, the Kenyan team was accompanied by community guides in each EA. In Greater Accra, the field team first visited the Municipal Assembly to introduce the project to the Assembly officials and the Environmental Health Officers. After the introductions, the field team with the assistance of the environmental health officers visited the community to conduct the reconnaissance visit.

Following field reconnaissance, six EAs in Kisumu and 35 EAs in Greater Accra were excluded as lacking slum characteristics and random replacements selected.  Two further EAs in Greater Accra were replaced because of concerns for field team security during preliminary fieldwork. Two replacement EAs were also used for pre-testing of the survey methodology in each city.

All retail outlets selling foods or beverages in the selected EAs were listed, and then one large (i.e. a supermarket or open market, where present) and one small retail outlet was sampled at random from these lists within each EA. Sampling was thus stratified by shop type. Restaurants, hotels and takeaways were excluded from the selection. In Kenya, a total of 251 retail outlets were listed, with 104 randomly selected for data collection. 508 retail outlets were listed in Greater Accra, of which 102 were visited for the market survey, reflecting the additional effort to select larger retail outlets described below.

During the main market survey, field enumerators observed how shoppers purchased food and beverage products from the selected retail outlets. At each retail outlet, five adult shoppers were interviewed using a short questionnaire.

Five food and beverage products wrapped in plastic were purchased per retail outlet as observed when shoppers visited these stores. Barcodes were placed on each purchased food and beverage product, plastic bag and unwrapping for subsequent identification of plastic packaging. After the market survey was conducted to purchase food and beverage products contained in plastics, in Ghana one third of the items bought were sent to the laboratory for further investigation including identification of resin codes on the packages. In Kenya, all plastic samples were characterized in the laboratory.

Following initial sampling of retail outlets, it became apparent that larger retail outlets (i.e. open air markets and supermarkets) were under-represented in the survey, despite playing a critical role in serving the communities being studied. Therefore, a subsequent follow-up exercise listed and sampled all open air markets and supermarkets nearest to the selected EAs. In Ghana, a total of three large retail outlets (supermarkets) and twenty-two open air markets were successfully sampled via this follow-up exercise.

Field work for Ghana started on 31st August and ended on 24th November 2021 whereas field work in Kenya started on 17th August 2021 and ended on 21st October 2021.

Ethical approval

The study was approved by the Faculty of Environmental and Life Sciences Ethical Review Committee, University of Southampton, UK (reference: 55755; approval date 19th August 2020), by the Ethics Review Office of Jaramogi Oginga Odinga University of Science and Technology, Kenya (REF: ERC/23/6/20-4; approval date 19th August 2020), and by the Institutional Review Board of the Noguchi Memorial Institute for Medical Research, University of Ghana (Ref: 003/20-21; approval date: 2nd September 2020).

Field team recruitment, training, and organisation

This section summarises the characteristics of the team members to facilitate data interpretation.

**Kenya**

A team of 8 surveyors, an assistant field supervisor, a field supervisor and a Data Manager and a water quality technologist (the latter supporting the creation of a separate data set for a different project component) were recruited, giving the project a 14-member strong team, besides the 2 Co-PIs and the other project support staff (Table 1).

**Table 1:** *Characteristics of RAs and Field Staff for Kenya*

|  |  |  |  |
| --- | --- | --- | --- |
| **TEAM** | **CODE in SurveyCTO** | **QUALIFICATION** | **EXPERIENCE IN FIELD DATA COLLECTION IN RELATED FIELDS** |
| **Data Manager** | (6) | Higher National Diploma (food Science, Microbiology) | 29 years |
| **Field Supervisor** | 6 | Diploma (community Mobilisation and Animal health) | 20 yrs |
| **Asst. Field Superv.** | 2 | Diploma (Environment and Community Development) | 15 yr |
| **TEAM 1** | 1 | Form 4 (Certificate - Training in Community Development) | 4yrs |
| 9 | BSc. (Spatial Planning -JOOUST Student) | 2yrs |
| **TEAM 2** | 11 | Bsc. (Environmental Science) | 6yrs |
| 8 | BED.(Arts) | 1yrs |
| **TEAM 3** | 3 | BSc ( Applied Statistics) | 5yrs |
| 4 | Bachelor of Arts (urban and Regional Planning) | 3yrs |
| TEAM 4 | 9 | BSc. (Environmental Science – environmental Biology and health) | 4yrs |
| 7 | Form 4 (Certificate) | 1yr |

The off-grid areas where the RAs were to work in are prone to several security challenges.

An introductory presentation was made to the participants introducing them to the overall project objectives, design and the study area overlain with google maps and the Enumeration Areas (EAs), which were the smallest units in which they would operate during the study. They were also trained on techniques and processes of successful consenting, best field practices, and how to use google map navigation to locate the boundaries of the EAs. The final protocols, which had been refined by the project researchers, Co-Principal Investigators (Co-PI) and the Principal Investigators (PI) and loaded onto the SurveyCTO software platform were downloaded onto the tablets (Samsung TabA 2019 (T585)) that were acquired and issued to RAs for fieldwork. Hardcopy prints of the questionnaires were also made for use during the training. The Data Managers and project Investigators conducted the training. The entire team was taken through all the questionnaires which were projected on a wall screen from the SurveyCTO platform. This was to train them to gain competence in using SurveyCTO software. In addition, exhaustive discussions were also held on the various questionnaires checking for the logical flow, ambiguity and practicality of implementing the questions in a field situation to ensure uniformity in understanding and how to interpret them for clarity and consistency of observations. Adjustments were then made to the observation protocols in areas which were found wanting. Day two of the training was spent on practicing and role-plays within the office to ensure that the surveyors had gained the requisite competence to operate on their own in the field.

**Ghana**

The School of Public Health (SPH) project team comprised 4 enumerators, 2 team leaders, a Project Administrator, a Field manager and two Research Officers (RO). During the primary fieldwork, the Administrator and project researchers also served as enumerators. SPH made sure that those chosen for the experiment had previous expertise in collecting data using tablets during the hiring process (Table 2).

The 30 enumeration areas (EA) were divided among the groups based on how closely they were located to each other. This was done to avoid long travel times when moving from one EA to the other.

Once the enrollment and matching process was complete, an effective (1) day training session was organised both online and in-person, guaranteeing that all the COVID-19 restrictions were observed. The group from Southampton and Kenyan participated online, whereas the whole Ghana group attended in-persons. An introductory presentation was made to the members, presenting them to the general goals and project design. After the introductory session, there was a thorough review of the questionnaires for both the paper version and the surveyCTO platform to ensure the team understood the survey instrument and was well-equipped to collect the data from the field.

***Table 2: C****haracteristics of field staff for Ghana*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Groups | Role | **Code in Surveycto** | **Qualification** | **EXPERIENCE IN FIELD DATA COLLECTION IN RELATED FIELDS** |
| Both | Field Manager/ Data manager | Master access | B.A. Economics and Computer Science | 15 yrs |
| 1 | Team Leader | 1 | BA. Geography & Resource Development and Psychology | 8 yrs |
| 1 | Research Officer/ Enumerator | 4 | M. Public Health | 12 yrs |
| 1 | Enumerator | 6 | HND Accountancy | 13 yrs |
| 1 | Enumerator | 10 | BA. Economics and Entrepreneurship studies | 7yrs |
| 1 | Enumerator/ PhD Student | 2 | M. Public Health | 10 yrs |
| 2 | Enumerator | 7 | BSc. Business Administration | 3yrs |
| 2 | Enumerator | 8 | M. Public Health | 5yrs |
| 2 | Team Leader | 9 | MSc. Climate Change and Sustainable development | 13 yrs |
| 2 | Administrator/ Coordinator/ Enumerator | 5 | EMBA | 6 yrs |
| 2 | Research Officer/ Enumerator | 3 | M. Public Health | 3 yrs |

## Community entry and sensitisation

**Kenya**

Initially, a stakeholder workshop was planned to mobilise community leaders and government officers for the impending project activities. However, the onset of COVID-19 prevented such face-to-face physical meetings in the country, and stakeholders lacked the technology to attend an equivalent online meeting. Consequently, the project team met smaller groups of stakeholders in open spaces or community halls. The team held four meetings with the policy-level stakeholders, which included those in the environment (3 persons), water (4 persons), public health (2 persons), and administration sectors (10 persons) of the County and National Government of Kenya in their respective offices. With the policy and administration level stakeholders' consent, the team then moved on to the project sites. At these locations, the team held sensitisation/mobilisation meetings with the local chiefs and assistant chiefs, who then extended invitations to the various community leaders, including the village elders. On average, each of the meetings had between 5-10 participants. For each EA, a community guide deemed knowledgeable of the EAs and also known to residents was nominated to work with the RAs in their respective EAs. In many instances, project teams found community guides who also worked with the Kenya National Bureau of Statistics (KNBS) staff during the population census enumeration exercise, making it easy to identify the limits and boundaries of the EAs. In addition, some Community-Based Organisations/ NGOs operating in the waste management area in all the projects' sublocations were also met and sensitised.

Additional sensitisation was also carried out through presentations at public meetings of stakeholders such as Kisumu WASH Network (KIWASH), other development partners and the Kisumu County Government. For instance, the CO-PIs from JOOUST and VIRED attended the Kisumu County Environmental Strategy Development workshop. Some emerging results, such as those of nappies, became useful material for strategy development. The project team also participated in Kisumu County's version of the World Environment Day celebrations.

In summary, the sensitisation, mobilisation and engagement exercise was very successful and reached more stakeholders (approximately 80 participants) than was initially targeted (60) for the initial workshop.

**Ghana**

The team in Ghana also engaged key stakeholders (assemblymen/women and opinion leaders) at the community level to inform them about the project objectives and sought their support to carry out the research in the various communities successfully. The field team first visited the Municipal Assembly to introduce the project to the Assembly officials and the Environmental Health Officers. After the introductions, the field team, with the assistance of the environmental health officers, visited the community to conduct the reconnaissance visit.

## Pre-testing of methodology

In both cities, pre-testing took place in two EAs not selected for the main survey. In each EA, two retail outlets were selected and five shoppers per retail outlet interviewed to pre-test the questionnaire. Alongside refinements to survey instruments, problems encountered during pre-testing included the following:

* Unwarranted suspicion of those retailers owning temporary stalls or Kiosks imagining the team was actually a precursor to demolition squads.
* Delay in retail outlets opening for customers impacting on the speed of the survey.
* Some retail outlets were not as popular as others, meaning that survey teams had to spend a longer time at those outlets finding sufficient shoppers to interview.

Solutions included the following:

* Booking appointments with shop keepers to ensure that retail outlets were open when teams visited.
* For outlets that were unpopular and had fewer customers, an early morning visit was recommended.

## Field data management

All the finalized forms or questionnaires covering various aspects of the project were uploaded on to SurveyCTO platforms and downloaded into the Samsung TabA 2019 (T585) by the survey team. Each surveyor was given a unique identity Code to access and download the forms from the SurveyCTO platform and deploy for use in recording observations and short interviews with shoppers as guided by the protocols.

## Listing of Retail outlets

The survey team together with the supervisors first went round in all the EAs in the study area. In each of the EAs, the team first walked along the boundary of the EAs with the help of a live google map overlaid with the EA’s boundary and local guides. This delimitation walk was to ensure that they did not collect data outside of the selected EA. Once the EA’s boundary was delineated on the ground, the survey team then used **Form 1a** (attached) to go throughout the EAs and list all the retail outlets within it. They also recorded landmarks near each of the facilities and outlets as well as their GPS coordinates for later identification and location.

## Market Survey to sample food and beverage packaging

Once the randomized list was made available, the teams, each composed of two surveyors, embarked on the market survey of food/beverage packaging. The surveyors first located the selected sample retail outlet, explained the project to the staff at the retail outlet, seeking their permission to make observations and purchase samples of foods/beverages sold at the outlet. The surveyors then proceeded to record observations of how foods and beverages were packaged using **Form 2** (attached), purchased a basket of goods while observing the packaging process, labelled the packages by barcoding them and recorded them on a tracking sheet. The barcoded samples were transported to the VIRED International of University of Ghana office in and carefully stored for later characterization and identification. A total of 102 randomly chosen retail locations were successfully visited in Ghana and 105 in Kenya.

## Shoppers Survey

After establishing a relationship with retail outlet staff, the enumerators asked them about the optimum time of day when they received the most clients. Knowing this, the enumerators concentrated their efforts during busy periods at the outlet. The enumerators then chose five customers at random from the outlet and watched how and whether everything they purchased was wrapped or packaged for them. The clients were then contacted, their verbal informed consent sought for participation, and a short 5-question survey (Form 3, attached) was administered to them via the SurveyCTO platform using the tablet. A total of 493 shoppers were interviewed altogether in Ghana and 520 shoppers were interviewed in Kenya.

# Laboratory-based characterisation of Plastic Packaging and identification of plastic resin types

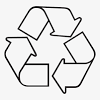
*Plastic sampling and characterization in Ghana*: After the market survey was conducted to purchase food and beverage products contained in plastics, the following processes were followed to obtain one-third of plastic samples for identification:

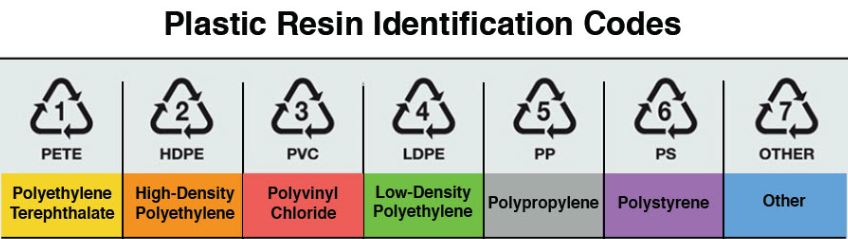
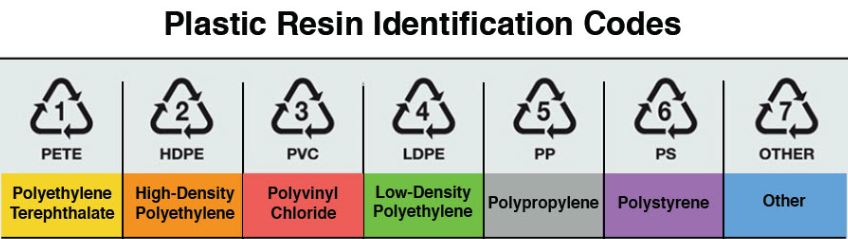
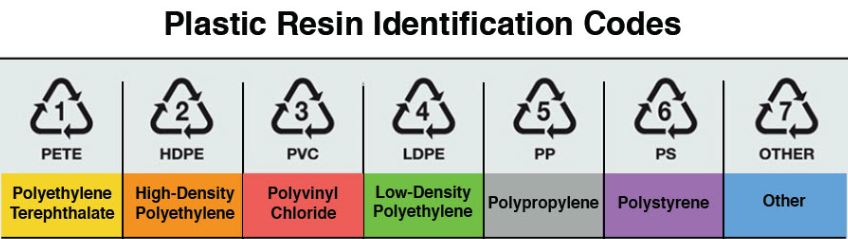
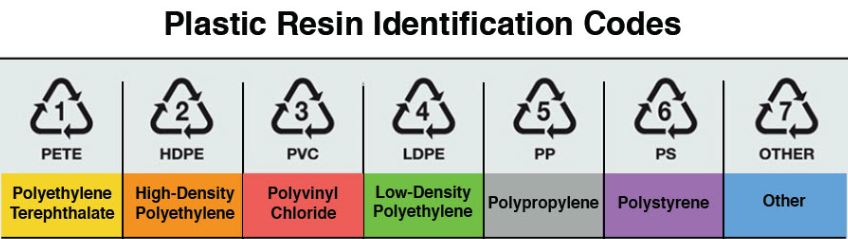
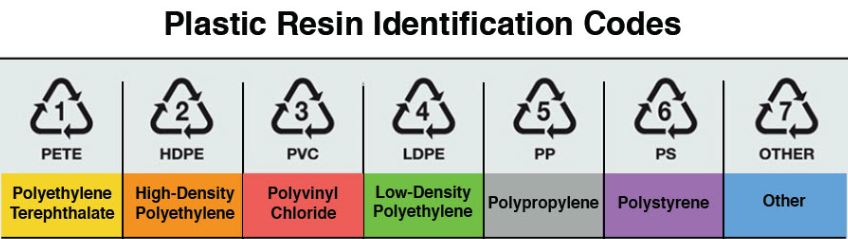
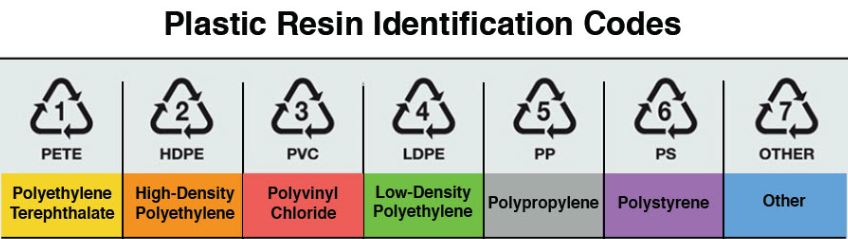
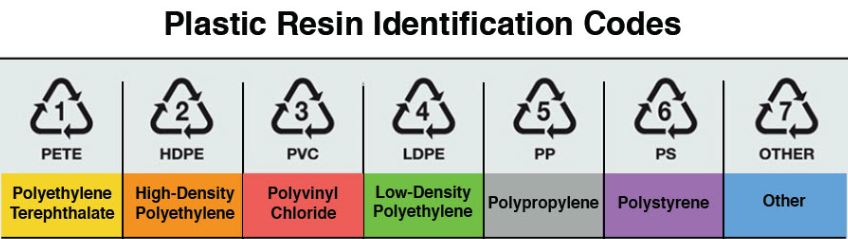
* Four independent observers characterized each packaging sample.
* 455 food and beverage products were purchased during the market survey data collection.
* Each product purchased had barcodes pasted on them for identification.
* Some items were purchased in packs, while others were individual items.
* Perishable food products and some other food items wrapped in paper or cardboard were excluded due to storage (spoilage).
* Before sampling one-third of the items, all products purchased were grouped based on their type and brand and one sample was processed for each brand and commodity type.
* Approximately one-third of all items purchased were selected based on the total number of each different product purchased.
* Items purchased singly with barcodes were also added to the list of samples.
* The content of the sampled products was emptied, and the packaging was cleaned for identification.

*Plastic sampling and characterization in Kenya*: For six days which started from the 6th to 13th of June 2022, four independent observers participated in the plastics identification exercise. In all, about 400 different plastic packaging were identified using the low-cost plastic resin I.D. method.

*Plastic characterization:* This consisted of questions on the utilization, characteristics and features of the plastic packaging recognized on the SurveyCTO Collect electronic platform. Each plastic selected to be identified had unique barcodes pasted on them during the market survey.

* The barcode was scanned, and the code was captured onto the system.
* The product or commodity type and brand were then recorded.
* After documenting the quantity of goods bought, the protocol recorded whether plastic container had been used for a different product before being sold.
* Next was answering a series of questions on whether the plastic packaging was used to wrap or contain one or many items, whether the plastic packaging was used for marketing or selling the product it came with, and whether the plastic packaging was used to protect and prevent contamination and damage to the product that was contained in them.
* Questions on the appearance of the plastic packaging were then asked to determine whether it was transparent, translucent or opaque. After which, a question was asked on the colour of the packaging provided it was not transparent.
* The next activity was to weigh the packaging on a scale and record the weight.
* Determine if any recycling symbols below could be seen on the packaging.



* Determine if any codes for the type of plastic resin below were embossed on the identified packaging.
* In a case where there is no resin code embossed on the plastic packaging, some series of questions were asked to determine some physical characteristics of the packaging like whether it is rigid or soft, its sound when rubbed between the fingers, how the edges feel when cut with a knife, whether there are white marks when cut with a chisel, whether it stretches or not, whether it can be scratched with fingernails or whether fragments of the plastic packaging floats or sinks when pressed under water.
* Many of the products had packaging made up of different plastics that needed identification. An example is a pack of soft drinks having the plastic bottle (primary container) made up of one type of plastic, the lid made up of a different type of plastic and its outer wrapping (secondary wrapping) also made up of a different type of plastic. Another example is a pack of biscuits with its primary wrapping being one type of plastic while its secondary wrapping and possibly tertiary wrappings are each made of different plastics. In this situation, the same plastic sample barcode is repeated for each of the different packaging components.
* Barcodes are also repeated because four different observers characterized each plastic sample.

## Laboratory work in Ghana was completed between 9th and 13th June 2022. In Kenya, laboratory work was completed between 19th July and 6th September 2022.

**Description of Low-cost method for identifying plastic resin types in food and beverage packaging**

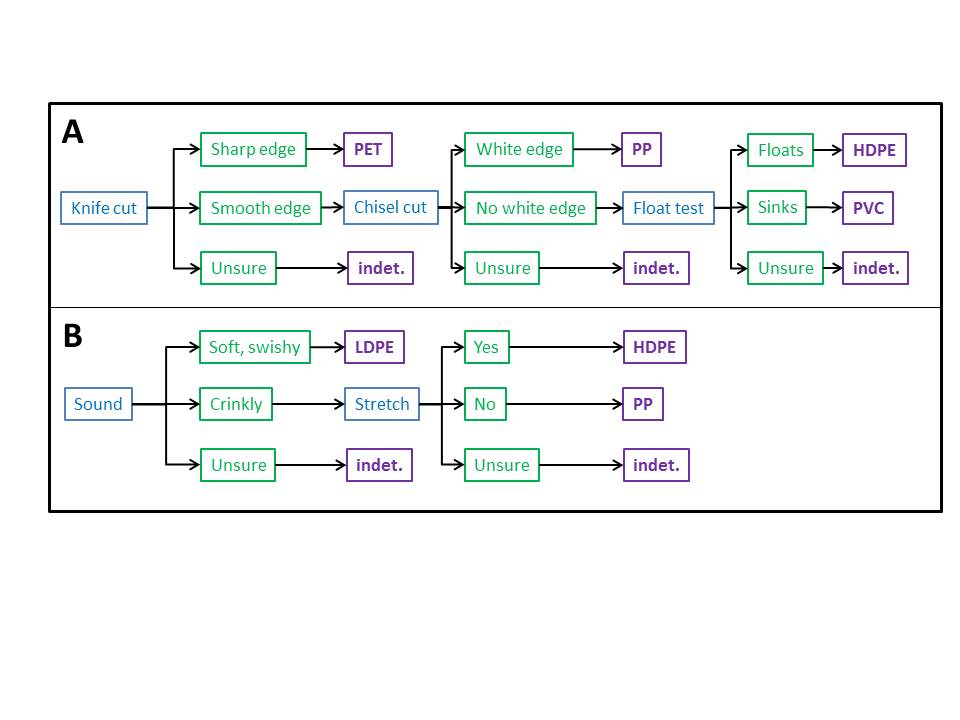
Properties and attributes of common plastics were compiled and, where appropriate, differentiated by format (i.e. rigid or flexible) (Table 3). Only those properties and attributes suitable for simple testing and/or readily observable were considered; some approaches to resin identification (e.g. burning plastic samples or assessing plastic resin density through floatation of samples in liquids of different densities) were excluded on this basis.

|  |  |
| --- | --- |
| **Plastic resin (ASTM code)** | **Format, properties and attributes** |
| PET (1) | Format: usually rigid  Transparent or tinted; easily cut, leaving a sharp edge; sinks in water. |
| HDPE (2) | Format: rigid or flexible  Rigid format: often opaque and coloured; easily cut with smooth edge; floats in water.  Flexible format: thin films can be transparent, thicker sections translucent; if rubbed together will make a crisp, “crinkly” sound; stretches easily. |
| PVC (3) | Format: usually rigid or semi-rigid  Transparent or coloured; easily cut, leaving a smooth edge; sinks in water. |
| LDPE (4) | Format: usually flexible forms, but also rigid  Flexible format: thin films can be transparent, thicker sections translucent; if rubbed together will make a soft, “swishing” sound; floats in water; stretches easily. |
| PP (5) | Format: rigid or flexible  Rigid format: low gloss; easily cut leaving a smooth edge; when cut with a chisel the cut edge appears white; floats in water.  Flexible format: thin films can be transparent, thicker sections translucent; if rubbed together will make a crisp, “crinkly” sound; does not stretch easily. |
| PS (6) | Format: usually rigid  Lightweight, can be clear or opaque; often brittle and breaks easily; sinks slowly in water. |
| EPS | Format: usually rigid  Lightweight (“foam” or “styrofoam”), opaque; breaks easily but is not brittle; floats in water. |

*Table 3: Format, properties and attributes of plastic resins commonly used for packaging household food and beverages (CS Recycling, 2014; Katz, 1998; TWI Global, 2023). ASTM Code indicates the number assigned to each resin via the ASTM (2010) system. Adapted from Shaw et al. (2022).*

The properties and attributes of these common plastics (Table 3) were brought together into a flow chart intended to incorporate combinations of tests to facilitate identification of plastics in common use.

The framework (Figure 1) used different sequences of tests and observations for flexible versus rigid plastic samples. For all items, tests were sequenced such that observations are made prior to cutting, and then pieces of materials are cut and used for further tests; this approach aligns with the practicalities for handling and testing packaging samples.



*Fig. 1. Flow chart of identification tests for* ***A*** *rigid plastic packaging items and* ***B*** *flexible packaging. Blue text indicates tests (Table 4), green text indicates outcomes of tests (Table 4) and purple text indicates identification outcomes based on properties and attributes of the different resins (Table 3). “Indet.” indicates an indeterminate identification outcome.*

This framework enables, in principle, identification of two plastics (PS and EPS) using no more than a visual inspection. Following determination of format (rigid or flexible), rigid packaging should be identifiable with no more than three further steps (Figure 1). Similarly, flexible packaging should in principle be identifiable in one or two steps after determination of format (Figure 1).

In order to support consistency in this regard, short video films were made to demonstrate and illustrate the tests and observations to hand (see <https://waterandwaste.org/> ). Exemplars of different formats and resins were provided to observers as reference materials. In the case of two tests, we noted that standard procedures might be applied to positive effect. To this end, we specified standard approaches for tests (Table 4) corresponding to the identification framework (Figure 1), as summarised (Table 4).

|  |  |
| --- | --- |
| **Applied to:** | **Observation or test** |
| All packaging items: | Is the item “rigid” (self-supporting; not easily forced out of shape) or “flexible” (not self-supporting; easily re-shaped? |
| Rigid packaging items only | Is the item lightweight, soft to the touch and pliable? |
| Bend the item with the hands. Does it break? |
| Cut the packaging with a sharp knife. Is the cut edge smooth or sharp to the touch? |
| Cut the packaging with a sharp chisel, held at an angle of 30-45° to the surface of the item. Does the cut edge appear white? |
| Cut three pieces of the packaging, each approximately 1cm x 1cm. Do these pieces float or sink in a glass beaker of water when pushed under the water surface and without air bubbles adhering to the surface? |
| Flexible packaging items only: | Rub the packaging together between the fingers and thumb. Does it make a “soft, swishing” or a “crinkly” sound? |
| Cut a strip of the packaging about 1cm wide and 10cm long. Hold the piece firmly between two hands and pull; does it stretch? |

*Table 4: Summary of tests and observations used in conjunction with the identification framework.*

## Protocol variations between countries and known data issues

Plastic sampling protocols for laboratory characterisation differed between Ghana and Kenya. As noted above, four observers independently recorded packaging characteristics in Kenya to enable inter-observer agreement assessment of the low-cost method for plastic resin type identification. In Kenya, all packaging samples were processed, whereas in Ghana, approximately one third were processed, discounting repeated plastic samples representing the same food or beverage commodity and brand.

There are also some known minor residual data quality issues in Ghana:

* A separate field for quantities of commodities sold in tins only was inadvertently retained in Ghana’s market survey table. Quantities for all other measurement units apart from tins are stored in a separate field (see data dictionary).
* There are some duplicate identifiers in some of the Ghana tables. There are five duplicate packaging barcodes and the shopper identifier EA28R0008S5 was inadvertently used repeatedly for multiple respondents.

## Data management, processing, quality control, linkage and anonymisation

*Data management:* All the finalised forms or questionnaires covering various aspects of the project were uploaded onto SurveyCTO platforms and downloaded into the Samsung TabA 2019 (T585) by the surveyors.

*Quality control:* Quality control measures undertaken during and following data collection included the following:

* Range checks were coded into SurveyCTO data entry forms, e.g., preventing negative counts of waste items.
* Coordinate data were mapped and checked.
* Checks and skip patterns were coded in SurveyCTO forms to ensure all required information was filled appropriately.
* Constraints were coded into SurveyCTO forms to restrict entry of future dates for date variables.
* Restrictions were placed on the number of characters entered for text field e.g IDs to ensure consistency.
* Enumeration Area ID (EA ID) and Retail Outlet ID were entered twice, at the beginning and end of the questionnaire as a control check for accuracy.
* Field supervisors and CO-PIs routinely made random checks on the data collection process by following surveyors to the field and observing the process.
* Field supervisors reviewed data queries and error logs working hand in hand with the data manager and surveyors.
* Where relevant, duplicate records were flagged and removed from the data using unique IDs
* All obsolete test data, e.g pre-test data, was omitted from the final dataset.

*Calculated fields:* To aid analysis, the following fields have been automatically calculated:

* Survey start / end time, upload time, and interview / observation duration: Automatically captured via tablets used for data capture.

*Anonymisation:* Field team member names have been removed, and comments or other free text fields in the data file have been screened for inadvertent disclosure of personal data. Coordinates (latitudes and longitudes) have also been removed from data files.

*Data structure, linkage & related data resources:*

Files are as follows, with the structure and set of files largely duplicated for each study country.

The data files comprise eight tables as .csv files, four for each country. In each country, there is

1. a table of retail outlet characteristics selling foods or beverages
2. a table containing responses to a short questionnaire interview with shoppers at these outlets
3. A table based on market survey observations of packaging behaviours at the outlets. The market survey table is in long format, so there are groups of fields concerning packaging observations that are repeated for different foods or beverages packaged at the same retail outlet.
4. a table of plastic packaging sample characteristics as observed in a basic laboratory.

Each table has an accompanying data dictionary, which explains the meaning of numeric value labels for particular fields, as well as the measurement units (where applicable) and content of each field in the table. The market survey form, which records observations about packaging for different foods and beverages at the same retail outlet, is in long format. Thus, groups of fields are repeated for different foods or beverages and for primary and secondary packaging observations within the same record.

Several key entities in the survey have unique ID fields and the format for the IDs is explained in Table 3 below. Retail outlet IDs can be used to link the market survey field and shopper questionnaire responses to retail outlet characteristics. Meanwhile, barcodes for packaging samples can be used to relate records for laboratory-based observations of packaging samples to the market survey record describing the retail environment from which they were collected.

The numeric codes for food and beverage commodities were intentionally designed to be harmonised with those used in the Ghana Living Standards Survey Round 7 (Ghana Statistical Services 2018) and the Kenya Integrated Household Budget Survey 2015-16 (Kenya National Bureau of Statistics 2018). Separate look-up tables are provided for these codes and commodity codes can be used to link packaging information to these nationally representative household expenditure surveys. In Ghana, a look-up table has been provided to act as a cross-walk between commodity codes in the GLSS7 and those in this data set.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Composition** | **Example** | **ID Example** | **Tables** |
| Enumeration Area (EA) | EA + 2 digits depicting the A (01 – 50) | Enumeration Area 01 – 50 | EA01 – EA50 | All |
| Enumerator ID | Numeric ID |  |  | All |
| Retail Outlet (Ghana format) | EA(2 digits) + R + 4 digits (in Ghana) | EA01, 1st Retail Outlet | EA01R001 | Retail outlets, shopper survey, market survey |
| Retail Outlet (Kenya format) | EA(2 digits) + [optionally OM or SM if open market or supermarket] R + 3 digits (in Kenya) | EA01, 1st Retail Outlet | EA01R001 | Retail outlets, shopper survey, market survey |
| Shopper ID | EA(2 digits) + R(3 digits in Kenya or 4 in Ghana) +S(1-5) | EA01, 1st Retail Outlet, 1st Shopper | EA01R001S1 | Shopper survey |
| Packaging sample barcode IDs: Kenya | WW-B + 4 to 6 digits+[A or B]1 |  |  | Market survey, packaging characteristics |
| Packaging sample barcode IDs: Ghana | WW- + 4 digits + [-DC or -CC]2 |  |  | Market survey, packaging characteristics |

*Table 3: Format of identifiers used in different tables within the data set. 1 A or B is used as an ID suffix in Kenya where a packaging sample has been separated into two different constituent parts, which are then characterised separately. 2The allocation of barcodes ending CC versus DC is entirely random in Ghana.*

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