# SUSTAINABLE PACKAGING MATERIALS FOR PROCESSED FRUITS AND VEGETABLES IN EAST AFRICA: A CASE STUDY OF NAIROBI, KENYA

Chaoqun Chen, George O Abong, Sebastian Hartwig & Gudrun Keding*

**ABSTRACT**

Packaging of processed fruits and vegetables contributes to reducing food waste and maintaining nutritional quality yet, at the same time, excessive use of packaging material creates environmental challenges. The purpose of this paper is to explore the views of different stakeholders including food processors and consumers on sustainability of different packaging materials used with several processed fruit and vegetable products available in East Africa. Four focus group discussions (FGD) and 14 key informant interviews were conducted in Nairobi, Kenya.

Thematic analysis was performed and consumer and processor views were categorized into eight themes: packaging material; communication; pack size; protection and preservation; convenience; price aspects; sustainability; and novelty and innovation. The results show that the issues of "packaging material" and "communication" on the packaging were most important. It became apparent that different understandings of the terms "sustainability" and "bio-degradable" exist, that "re-use" is seen as a normality, not necessarily as sustainable, and that there exist uncertainties about a package being "disposable", "recyclable" and "reusable". One major challenge for sustainable packaging appears to be how to communicate to stakeholders the concepts of sustainability and its benefits.

Overall, challenges in identifying and communicating sustainable packaging and ways to improve the sustainability of different product categories were found. The qualitative analysis recognised areas for further research using quantitative methods to find solutions for local plastic recycling and testing local sources for biodegradable packaging alternatives. Research is needed to potentially improve food packaging both for producers and consumers in East Africa.

***— Ms C Chen***
Department of Crop Sciences
Division of Quality of Plant Products
Georg-August-Universität Göttingen
Carl-Sprengel-Weg 1
37075
Göttingen
Germany
E mail: chaoqun.c@yahoo.com

***— Dr GO Abong***
ORCHID ID: 0000-0003-2524-7862
Department of Food Science, Nutrition and Technology
University of Nairobi
PO Box 29053-00625
Kangemi
Nairobi
Kenya
E-mail: georkoyo@yahoo.com

***— Mr S Hartwig***
ORCHID ID: 0000-0001-8642-2789
Department of Crop Sciences
Division of Agricultural Engineering
Georg-August-Universität Göttingen
Gutenbergstraße 33
37075
Göttingen
Germany
E mail: sebastian.hartwig@uni-goettingen.de

***— Dr G Keding****
ORCHID ID: 0000-0001-6215-0969
Department of Crop Sciences
Division of Quality of Plant Products
Georg-August-Universität Göttingen
Carl-Sprengel-Weg 1
37075
Göttingen
Germany
E mail: gkeding@gwdg.de
*Corresponding author

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## INTRODUCTION

The last two centuries have seen food packaging evolve from being simply a container to hold food to something that can play an active role in food protection and preservation, facilitating logistics as well as communication, i.e. aspects of information on the package (Risch 2009; Rolle & Enriquez 2017). Meanwhile, increasing awareness has been raised about the environmental burden caused by food packaging, because the production of packages tends to be associated with resources depletion and the throwaway culture makes most of the discarded packaging a rubbish problem (Han et al. 2018; Wikström et al. 2014).

From a global perspective, one strategy to facilitate the sustainability transition of packaging is the promotion of bio-based polymers, whose raw materials are from a renewable resource such as biomass waste instead of being based on fossil fuels. However, according to recent reviews by Korte et al. (2021) and Beltran et al. (2021), the use of bio-based polymers in industrial applications is often restricted due to lower performance characteristics in fundamental packaging functions. The latter can directly influence food quality, food safety and shelf life: a whole range of factors work against the replacement of conventional plastic packaging.

Next to these technological factors, a critical issue is how consumers and processors perceive sustainable packaging. Consumers as well as food processors have their own specific views on what food packaging should provide and this depends on the food type and on the geographic location. In this study the aim was to obtain insights into consumer and processor views specifically on packaging for processed fruit and vegetables (FVs) in East Africa, here exemplified by products developed by the FruVaSe project (FruVaSe 2018). In this project – "Fruits and Vegetables for all seasons" – University partners from Kenya, Tanzania, Uganda and Germany work together on improving processing techniques for surplus fruits and vegetables, make the techniques resource-efficient and find market solutions for the new products. As fruits and vegetables are highly seasonal, perishable and in surplus during the peak season they are often wasted and lost for consumption. The processing of local fruits and vegetables is a key issue for food and nutrition security while the packaging of these products is an important step in the value chain.

FruVaSe products (Table 1) are grouped into (i) juice/nectar, (ii) dried fruits, (iii) dehydrated powder and (iv) vegetable relish. These are products that can be found in all three project countries as well as in other East African countries. Product developers in the FruVaSe project face strategic challenges making decisions about which packaging is more sustainable and what packaging they should use for their products. Therefore, this study aimed to increase knowledge on this topic seeking the views of both consumers and processors who

**TABLE 1: PRODUCTS BEING DEVELOPED BY THE FRUVASE PROJECT – FRUITS AND VEGETABLES FOR ALL SEASONS IN KENYA, TANZANIA AND UGANDA**

| Country | Fruit products | Vegetable products |
|---|---|---|
| **Kenya** | Guava **nectar** | Cowpea leaves **soup** mix (dried powder) |
| **Tanzania** | Cashew apple **juice** | African nightshade **pickle/ relish** (fermented) |
| | **Dried** cashew apple | Vegetable **sauce** (cooked) |
| **Uganda** | **Dried** jackfruit products (powder/ flakes) | Cassava leaf **sauce and powder** |
| **All countries** | **Dried** fruit-nut bar from jackfruit or guava plus other fruits & nuts | |

are already in the business. This would assist processors of all sizes in their decision-making and improve packaging design practice, in particular for the difficult category of processed FVs.

## THE SITUATION OF PLASTIC IN EAST AFRICA

In the East African Community (EAC), comprising Burundi, Kenya, Rwanda, South Sudan, Tanzania and Uganda, Rwanda is known as the first EAC country to implement a ban on plastic bags in 2008 (Danielsson 2017). In 2007, Uganda attempted to announce a ban on the "importation, manufacture and use of plastic materials made of polymers of less than 30 microns". Nevertheless the government halted enforcement after industrial opposition (Mirembe & Halima 2019).

In 2017, the Kenyan government instituted Gazette Notice No. 2356 banning "the use, manufacture and importation of all plastic bags used for commercial and house hold packaging" (Authority of the Republic of Kenya 2017; NEMA n.d.). This ban is the third attempt to combat the environmental nuisance across Kenya. In 2007, Kenya made a less ambitious effort to curb the use of plastic bags by banning the manufacture and import of plastic bags up to 0.03 millimeters in thickness and imposed a universal 120% tax on plastic bag use. Four years later in 2011, Kenya tried to do away with plastic bags up to 0.06 millimeters in thickness. Both of these initiatives were not implemented (Goitom 2017; The Economist 2017). The plastic bag ban announced in 2017 was commented by Aaron Brooks as "one of the world's strictest bans on plastic bags" as the fines are up to $38,000 and the prison sentences are up to four years for a single offence (Brooks 2019). This was one year after EAC's releasing of Polythene Materials Control Bill (EAC 2016): an act aiming to control and regulate the use, sale, manufacture and importation of polythene materials. While the bans mainly concern carrier bags, the regulation of polythene materials also affects general plastic packages, which are important packaging for FV products.

This study focused on FV products in particular, as a general problem is that FV consumption in East Africa is far below the recommended daily amount of 400g per person (Ruel et al. 2005; WHO 2003). This is partly due to seasonal availability of these highly perishable foods. This is why locally-processed FVs should bridge the seasonal gap. However, for this to happen they need reasonable packaging which takes into account food safety, accessibility and sustainability issues as well as consumer and processor perspectives and requirements which are the focus of this study.

## MATERIALS AND METHODS

This study uses data from on-site focus group discussions (FGDs) and key informant interviews with stakeholders in Nairobi, Kenya. The study explored consumers' and processors' views on different aspects of processed FV packaging and the perceived sustainability of different packaging materials. Although data were only collected in Nairobi, Kenya, the key informant interviews in particular, could be relevant for other East African countries since nearly half of the interviewed processors sell their products across East Africa. A qualitative research method was adopted (Given 2008a) in order to answer the following main research questions:

1) What are consumers and processors views on different issues (explained in detail below) around fruit and vegetable packaging including "sustainability"?
2) What are the available and accessible packaging options in Kenya and EAC in general for the FV products of interest?
3) What type of packages do different stakeholders prefer and why?

## FOCUS GROUP DISCUSSIONS

Four Focus Group Discussions (FGDs) (Krueger and Casey 2009) were carried out in Nairobi, the capital of Kenya, two with participants from middle-income households and two with participants from low-income households. In the FGDs, the first part questions were designed to elicit participants' perceptions on processed FVs packaging. This included i) packaging in EAC; ii) packaging of FV products; iii) whether buying FV products is influenced through the packaging; iv)

how important different attributes of a package are; v) naming the best FV packaging and vi) the worst FV packaging they have seen so far and why; vii) the ideal type of food packaging; and viii) how the package is managed after the product is finished.

In a second part, the projective technique was used by showing typical FV packages purchased from different markets in Nairobi accompanied by various questions, to better understand the target groups' attitudes that could not be revealed through direct questioning. It was hoped to reveal participants´ attitudes, experiences and reactions in a way that could not be achieved through other research methods, e.g. questionnaires or observational studies (Gibbs 1997).

FGDs included seven to eight participants each over the age of 18 years who had lived in the EAC for at least 10 years. Participants were recruited as a convenience sample (Given 2008b), with the first two group consisting of administrative personnel and students from the University of Nairobi (group 1 and group 2, middle-income households). The other two groups (low-income households) were contacted through colleagues from the University of Nairobi and a recruited local guide: group 3 in Kawangware area and group 4 in Lenana area. Participants were informed in advance that the topic of the discussions would be food packaging with respect to processed FVs. Participants gave their oral consent and all discussions were held in July 2019. In Nairobi, Kenya, approvals were sought from local administrations and company representatives before conducting focus group discussions and key informant interviews. Ethical approval for the overall FruVaSe project was received from the University of Goettingen's ethics commission.

## KEY INFORMANT INTERVIEWS

In total, 14 processors of fruit and vegetable products in and around Nairobi were interviewed

**TABLE 2: BACKGROUND INFORMATION SUMMARY OF PROCESSORS INTERVIEWED IN NAIROBI, KENYA (KEY INFORMANT INTERVIEWS)**

| Code | FV product of interest | Year of establish-ment | Employee number | Customers | Packaging main materials |
|---|---|---|---|---|---|
| **IP-1** | Sauce | 2017 | 8 | Local markets: hotel; fast food retailers; supermarkets | Plastic |
| **IP-2** | Dried fruits, juice | 2010 | 20 | Local markets & export markets | Compound materials |
| **IP-3** | Powder | 2010 | 1 | Local markets | Plastic |
| **IP-4** | Dried fruits | 2008 | 300 | Local markets: wholesalers; other food processors & export markets | Compound materials |
| **IP-5** | Sauce | 2014 | 6 | Local wholesalers and local stores | Plastic |
| **IP-6** | Sauce | 2017 | 3 | Local markets: wholesalers; local stores; online | Glass |
| **IP-7** | Jam | 2014 | 4 | Local markets: shops; door-to-door | Plastic |
| **IP-8** | Sauce | 2015 | 10 | Local markets: wholesalers; supermar-kets | Plastic |
| **IP-9** | Sauce | 2015 | 7 | Local markets: café; restaurant; food institution/ establishments | Glass |
| **IP-10** | Dried fruits* | 2017 | 10 | - | Plastic |
| **IP-11** | Dried fruits | 2010 | 9 | Local markets: supermarkets; private orders & export markets | Plastic |
| **IP-12** | Juice, sauce | 1992 | 600 | Local markets: supermarkets; wholesal-ers & export markets | Plastic, compound materials, metal |
| **IP-13** | Juice | 2008 | 75 | Local markets: hotels | Plastic |
| **IP-14** | Juice, dried fruits, powder | 1985 | 250+ | Local markets: wholesalers; own shop chains & export markets | Compound materials |

* under development, not in the market yet

individually. The selection of respondents for key informant interviews were the result of convenience sampling (Given 2008b) and snowball sampling (Morgan 2008). Lists of key informant interviewees were firstly compiled based on an internet search, complemented by information collected during store checks and the local guide's personal communication. Snowball sampling was used and interviewees were asked whether they could introduce the project team to other stakeholders who may be of interest to this study. In total 14 key informant interviews were performed, all conducted face-to-face at the interviewee's working place. Table 2 gives an overview of interviewed processors and the code, which was given to each questionnaire/ interviewee to ensure anonymity and was used later for quotation.

## PROCEDURE

In the first part of the FGD, discussions between participants was encouraged through eight different open-ended questions (all questionnaires used are available upon request from the corresponding author). In the second part, three different packaging options for each product group (without content) available in normal supermarkets were presented to the participants (Table 3). The packages were brought to the participants and passed around so that everyone was able to have a close look and feel the material. The participants were asked which packaging option they preferred and their reasons. This was intended to stimulate good discussions in a more realistic context and to uncover points that were not mentioned in the first part. FGDs were always carried out by a discussion leader and a note taker and, after asking participants and agreeing on the most appropriate language, English was used.

During key informant interviews, questions with a different focus were asked, based on the stakeholder's role, namely: representatives of ministries and agencies; industrial actors/ small-entrepreneurs in the processing industry; or industrial actors/ small-entrepreneurs in the packaging industry. The questionnaire was structured in the following way:

- Background information about the agency, enterprise, organization
- For ministries: macro-environment: policies and regulations, plastic bag ban, future trends
- For processing industry: micro-environment: type of products, packaging material – access/ availability, alternatives, automation, environmental profile
- For packaging industry: micro-environment: type of raw material, type of packaging, improvements, environmental issues, future trends

## DATA ANALYSIS

Transcribed material from FGDs and key informant interviews were subject to thematic analysis (Boyatzis 1998; Knight et al. 2007). Initial themes for coding were identified based on the aspects of packaging listed by Rundh (2005). The themes finally used in this study were identified from the FGD and key informant interview results. For this, the transcripts were reviewed and searched for statements made repeatedly by participants and interviewees. All related statements associated with one or more of the initially ten themes were coded accordingly. In the second step, the coded material was further scrutinized, yielding a number of sub-themes (e.g. 1a-c, covering different aspects of packaging material) relating to the initial themes. Finally, eight major themes were chosen to focus on.

## RESULTS

The thematic analysis of the interviews resulted in eight themes, namely: (1) packaging material; (2) communication; (3) pack size; (4) protection and preservation; (5) convenience; (6) price aspects; (7) sustainability; and (8) novelty and innovation. The first two themes were also the most discussed, namely packaging material and communication. Application of the projective technique revealed issues where the participants had mixed views and attitudes regarding different packaging options which are discussed in detail below and are summarised in Table 3.

**TABLE 3: PACKAGING TYPES COMMONLY USED FOR FRUIT AND VEGETABLE PRODUCTS IN NAIROBI, KENYA, AND SHOWN DURING FOCUS GROUP DISCUSSIONS/ PROJECTIVE QUESTIONS AND SUMMARIZED MAIN PERCEPTIONS BY CONSUMERS**

| Product category | Main perceptions by consumers | | |
|---|---|---|---|
| | **Sample No.1** | **Sample No.2** | **Sample No.3** |
| **Juice/ nectar packages** | Beverage carton large | Beverage carton small | Plastic bottle |
|  | • Most preferred by middle class<br>• More attractive, gaining more trust and perceived better product quality | • Suitable for travelling | • Most preferred by middle class<br>• Preferred by working class<br>• Reusable<br>• Suitable for travelling |
| **Sauce packages *** | Plastic jar | Plastic bottle | Glas jar |
|  | | • Most preferred by middle class<br>• Preferred by the working class<br>• Convenient, easy to handle, reusable | • Most preferred by middle class<br>• More hygienic, yet delicate and breakable |
| **Dried fruit packages** | Plastic jar | Plastic pouch (compound material) | Laminated paper bag |
|  | • Most preferred by all groups<br>• Favoured by working class<br>• Reusable and re-sellable | • Second-most preferred by all groups<br>• Portable | |
| **Powder packages** | Plastic box | Plastic pouch (compound material) | Laminated paper bag |
|  | • Most preferred by middle class<br>• Can be filled with larger volume content than other two | • Second-most preferred by middle class (partially)<br>• Food less likely to get contaminated | |

* Package No.4 was not specifically rated; all pictures © (*name removed for blind review*)

**PACKAGING MATERIAL**

Under this theme, the research question on which packaging options are available and accessible for fruit and vegetable products was explored. The question of packaging preference was answered here from the consumer's point of view and is further elaborated in the remaining themes.

The common packaging materials mentioned during FGDs were plastic, paper carton,

beverage carton, paper and glass. As the preference of different packaging by consumers may be dependent on specific products, findings from FGDs are summarized in Table 3. Samples of FV packages were sought in the local retail shops and most packages available were partly or entirely made from plastic.

In general, the plastic bag ban changed the reputation of the packaging industry, yet, most consumers appreciated the convenience of different plastic packages. The most preferred packaging for juices and nectars by consumers were the large beverage carton and plastic bottle, the latter especially by low-income participants. For sauces, plastic bottles were most favoured while glass jars were also liked by the middle class with the main argument being hygiene. Plastic jars were most preferred by all groups for dried fruits while for vegetable powders plastic boxes were favoured (Table 3).

The customers of processors, especially foreign customers, might have specific requirements for packaging materials [IP-3; IP-11; IP-12]. For instance, IP-11 provided dried fruits in plastic pouches for local markets and the same products in aluminium laminated bags for the foreign markets, namely the United Kingdom (UK), Germany and Japan as requested.

It was noticed that the usage of plastic by processors was reduced but the extent of the reduction was limited. For example, IP-1 changed their secondary packaging from plastic bags to woven bags due to the plastic bag ban. Similarly, IP-11 turned to flexible pouches (compound material) like sample No.2 for dried fruits in Table 3 (still made partly from plastic) and plastic bowls (also still plastic but apparently considered differently). IP-13 started to add cans to beverage packaging, other than existing plastic bottles and carton options. IP-2 had changed their packaging materials from pure plastic bags to laminated bags for dried fruits. This change was made because a) it was advised by the National Environment Management Authority (NEMA), as the latter packaging was better for extending shelf-life of dried fruits; and b) the majority of dried fruit products in the markets were packed in this way.

**COMMUNICATION**

During the FGDs, packaging design received both positive and negative comments. Labelling received quite a few complaints for, in particular, not properly stating allergy warnings, and not providing how-to-use information, as one participant stated:
"*We need policies to ensure things inside are same as promoted on packaging. […] We should label preservative names and corresponding amount used accurately in case of allergy accident. This is done poorly right now*." [Group-1].

The appearance of a package may play an important communicative role. All four groups agreed that an attractive look could influence their purchase decision positively. There were different interpretations of "attractive", some mentioned colour while others spoke of images. Also, as one participant stated:
"*Sometimes, the type of packaging design that attracts the young people may be a fancy look and that would not attract the old*." [Group-1].

Quite a few participants stated that the expiration date on current packaging was not easily readable and could be improved by enlarging the font and printing it at a more obvious position [Group-1; Group-2; Group-3]. Notably, the presence of the Kenya Bureau of Standards (KEBS) mark was appreciated. Consumers from all groups stated that the KEBS mark is a proof of good quality, some even saw it as a guarantee of food safety and eco-profile.

**PACK SIZE**

In general, for (tomato) sauce products, there were a wide range of product sizes available in supermarkets, ranging from 50ml to 5 litres. Also, juices/nectars were available in different package sizes, usually in 1 litre but also smaller or larger. The consumption scenario was important for packaging size selection, as one participant put it:
"*If I buy it for travelling, I want to choose lighter packaging* (the 250ml portable carton instead of a 1 litre carton)." [Group-2].

Packaging improvements were made based on customer feedback, mostly for size [IP-1; IP-5;

IP-6; IP-7; IP-8; IP-9; IP-10; IP-12], in forms of increasing or reducing the quantity per pack or increasing the available sizes of products. For instance, in the case of IP-1, they did not have sauce products in 5-litre containers at first, rather in 350ml for household consumption. However, when they started to gain clients from the catering business, where cooks required sauce in 5-litre containers, they began to provide products in 5-litre form, too.

**PROTECTION AND FOOD SAFETY**

IP-6, IP-9 and IP-10 changed from plastic jars to glass jars for their products. The merits of glass jars included product quality, safety of product, spillage reduction and product stability/ longer shelf-life. By contrast, IP-7 changed from glass jars to plastic jars, because the shelf-life of their product "was greatly influenced" according to own perception, namely shortened, for reasons they had not been aware of and were not able to explain.

**CONVENIENCE**

Improvements, such as the design of label [IP-6; IP-7]; adding a sauce container with a flip top to the initial wider screw-open cap [IP-5; IP-8]; making the expiration date more visible [IP-8], and being more ergonomic and portable [IP-9] had been made already by the interviewed processors. In fact, FGD participants expressed mixed preferences for sauces packaged in plastic bottles: the flip top was thought to be more convenient while the wider screw-open cap–was considered better because it could be re-used easily by being refilled with salt or sugar. IP-8 recently added a more expensive plastic bottle with a flip cap and gave their customers the choice for different packages with different prices. In that case, the customer was to bear the increased cost of the packaging upgrade.

**PRICE ASPECTS**

Some consumers believed that by using a fancy packaging, the price of a product could increase substantially. However, that kind of spending was perceived to be unnecessary, as one should pay for the product itself, not the package. Most participants in the FGDs expressed their preference to buy fresh FVs instead of processed and packaged ones. Quite a few were very sensitive to the influence of packaging to a product's price, as one opinion from Group-2:

*"[…] I like to buy things with simple (cheap) packaging, I don't want to spend money on its packaging. e.g. tea leaves or seasoning powder in a tin is more expensive than in a plastic bag*."

In contrast to finding the cheapest packaging, processors try to find the appropriate package that matches the product position. IP-5, a producer for juices, in response to the feedback from their clients, changed from thin plastic bottles to harder plastic containers due to the former ones' being seen as "cheap-looking". A similar attempt to get rid of "cheap-looking" packaging was also reported by IP-10.

**SUSTAINABILITY**

When it comes to the sustainability of packaging, consumers mentioned that materials needed to be bio-degradable.

"*The type of material would inform whether it is biodegradable or not. I know paper is more sustainable than plastic. But there's plastic made from starch, they are also sustainable*." [Group-1].

Sustainability was literally interpreted by some potential consumers as the ability to physically sustain (or protect) the product (Table 4). Also, processors had different understandings of what exactly "sustainable packaging" meant to them: disposable [IP-3]; re-usable [IP-5; IP-6]; recyclable [IP-2; IP-4; IP-6; IP-8]; bio-degradable [IP-11; IP-13; IP-14], meanwhile fulfilling compliance with relevant government regulations [IP-12].

Processors from IP-1 and IP-6 were trying to build up their own recycling system by monetary incentives encouraging consumers to return HDPE bottles or glass jars after consumption. Among the three enterprises who were interested in bio-degradability of packaging, one company, IP-14, achieved 65% of their product

packaging being bio-degradable by importing the packaging. All the three enterprises agreed that the availability of bio-degradable packaging alternatives in Kenya was the main problem hindering their application.

## NOVELTY AND INNOVATIVE PACKAGING

The transparency of packaging material is appreciated in certain cases, especially for novel products.
"[…] *I want to check the colour of dried mango. For traditional food that I consume a lot (like grain flour), transparency is not so important*." [Group-1].

For small and medium enterprises (SMEs), the owner usually decided initially what packaging to use, based on personal preference and stable supply of packaging materials [IP-3; IP-5; IP-7]. With larger establishments, decision-making was more formal: the responsible department, e.g., research and development (R&D), gathered information of existing technologies and available choices in the market from publications to screen out several alternatives, before engaging with customers [IP-4].

## DISCUSSION

This research of stakeholder views on different perspectives of packaging for processed FVs in East Africa showed that consumers and processors view a wide range of factors differently. Regarding preferences by different income groups of consumers, cheaper options like plastic bottles were clearly preferred by low-income households while the middle class were in favour of plastic bottles and beverage cartons or glass jars. The latter were perceived to provide better product quality or were more hygienic. Higher product quality in beverage cartons can be due to light protection as light may cause degradation in nutrients or changes in sensory characteristics of the product (Duncan & Hannah 2012). Also, the assumption of consumers regarding glass is correct as it is chemically resistant to all food products, odourless (Grayhurst & Girling 2011) and can be cleaned at high temperatures. However, except the glass jars for vegetable sauces, all other packaging for fruit and vegetable products found in Nairobi, Kenya, were made from plastic or compound materials containing plastic. In order to cope with the plastic bag ban, some processors had turned to different packaging options. However, these also contained or were made of plastic such as plastic pouches, plastic bowls, laminated paper bags or woven bags.

The environmental impact of food packaging is a major challenge (Han et al. 2018) and therefore, special attention was given to the sustainability of different packaging options. It was noticed that the topic of "sustainability" was interpreted differently among FV processors and potential consumers. The latter were more concerned about information on the pack and the convenience, as well as the convenience to dispose of or re-use them which is part of the sustainability question. In contrast, processors placed more emphasis on the functions of preservation and convenience of handling.

## SUSTAINABILITY

In general, three sustainability aspects of food packaging can be differentiated according to Pauer et al. (2019). These are: i) direct environmental effects of packaging, ii) circularity, and iii) packaging-related food losses and waste. The sustainability of FV packages in this study was interpreted by stakeholders as physical duration or eco-profile. Eco-profile was further explained as a concept including easiness of disposal, easiness of recycling, and degradability. The first and second sustainability aspects of food packaging were apparently considered, while the third aspect regarding food loss and waste was not directly associated with sustainability. This is a major flaw, as food loss and waste is estimated to be about 37% in Sub-Sahara Africa and especially for highly perishable products which have their major losses not during post-harvest handling but during processing, packaging and distribution (Sheahan & Barrett 2017).

In terms of packaging material, paper was linked to better performance regarding environmental protection. Plastics were a worse contribution to the environmental balance. Glass and metal, compared to paper and plastics, were considered superior in terms of eco-profile as they can be easier re-used because they were less contaminated after being used for

packaging. This perceived sustainability of different packaging seems to be in line with what can be calculated through Life Cycle Assessment (LCA), although these calculations are highly complex and environmental impact indicators trends can be found only for some; e.g. that beverage cartons are superior to plastic or glass bottles (Falkenstein et al. 2010). As with the issue of packaging-related food loss and waste, the issue of circularity is often not considered. However, both are important topics to be addressed in future studies (Pauer et al. 2019). For the four product categories in this study, LCA was calculated for different packaging options using many assumptions reported elsewhere (Chen 2020). The most sustainable options were difficult to determine as that mainly depends on the number of times that packaging can be re-used. For (i) juice/ nectar PET plastic bottle with re-use scenario was the best option; for (ii) dried fruits a plastic jar with re -use scenario; for (iii) dehydrated soup powder mix a craft paper bag; and for (iv) vegetable relish a light glass jar would be the best choice in terms sustainability (Chen 2020).

Packs that can be easily re-used after their primary use were popular among consumers. Interestingly, this was not mentioned as “sustainable”, yet it was first of all simple, practical and cheap. Re-utilisation mainly included re-use of the pack by filling with other goods, to re-sell the used pack to people who are specialized in collecting them or to burn the pack as a fuel source for cooking. That burning of plastic or composites may cause health problems, especially respiratory diseases (Sana et al. 2019; Verma et al. 2016) was not mentioned or was ignored by the participants.

While most consumers in Kenya found the re-use option of a packaging important it was interesting to see that only two processors thought that re-using of packaging is sustainable while at least four processors thought that recyclability of packaging is sustainable. The constraints for the latter were clearly that recycling systems still have to be developed. From previous studies it is known that in Kenya, although innovative actors are present in the plastic production, waste and recycling system, clear recognition and guidelines by the government are missing so that there is currently no closed circuit for plastic (Oyake-Ombis 2015), or packaging material in general.

It became clear that some of the stakeholder perceptions were distorted: e.g., the term "plastic" covers a range of chemical names. The polyester mentioned during an FGD as opposed to plastics, was commonly used as a synonym of plastic (PET Resin Association n.d.). The woven bag, mentioned during a key informant interview, as opposed to plastic bag, is a classification of forming technology used during production and is not necessarily non-plastic. The term such as “bio-plastic” has two interpretations: it can mean plastics made from biomass or the biodegradability of the plastic. The biodegradability of a piece of plastic is not necessary causally related to its origins, but highly affected by its physical and chemical structure as well as the environment in which it is disposed of (Emadian et al. 2017). One major issue using bio-degradable packaging is that no material is available locally, as mentioned by three different enterprises in Kenya. However, there is increasing research by scientists on “green” packaging alternatives: bio-composites from banana or plantain fibre, coir, pineapple leaf, wheat straw, mango kernels and many others have been investigated to replace petrochemical polymers that are non-renewable (Berthet et al. 2015; Nawab et al. 2018; Reichert et al. 2020; Rodríguez et al. 2018; USDA 2002). Several of these materials area available in East Africa and call for more investigation into locally available bio-degradable packaging options.

**CONVENIENCE**

Processors had a preference for the packages that can be easily handled. Packages that can be handled manually e.g. for the filling process, were particularly favoured among start-ups. Glass jars and plastic packages could be easily formatted, filled and sealed manually, and were more commonly used among SMEs in Kenya compared with more sophisticated packaging solutions that need additional capital inputs such as beverage cartons. With this characteristic, processors interviewed preferred to buy half-finished packaging products, e.g., plastic sachets with one open-end that are easy for them to handle instead of cheaper upstream materials, e.g., sachet reel or films. Automation was hard to achieve among SMEs. This was

most likely due to the capital constraints mentioned by most SME owners in addition to relatively cheap labour costs in Nairobi. Investment in new machinery as well as research and development is usually seen as critical for SME growth, although it is not clear whether the transfer of technology from abroad can only have a positive impact on SMEs in Africa (Hansen et al. 2018).

For consumers, convenience was important depending on the situation when a package was used. For instance, when travelling portability was key. Opening was another point of discussion regarding convenience and interestingly screw tops was preferred by those who thought about re-using the packaging later on in their household while flip-top packages were obviously not re-used. The more convenient packaging was, the less environmentally-friendly it might be although nowadays there is an attempt to balance both the convenience and sustainability of food packaging (Lamontagne 2018). This should be one of the key objectives of fruit and vegetable packaging in East Africa.

## COMMUNICATION AND PRICE

Consumers were highly interested in package appearance: they wanted the package to be attractive, the expiration date to be more obvious and a KEBS label on the pack demonstrating the quality of the food as well as the packaging. However, in reality, the function of a typical KEBS label is for quality and safety, it does not guarantee eco-friendliness of packaging or the superior quality of the food (KEBS n.d.). In general, independent third-party labels were suggested to guarantee eco-friendliness. As long as no local third-party certification body exist, it is possible for organizations to apply to international bodies for certification of the whole product or elements of the value chain, such as EcoCert (Scott & Vigar-Ellis 2014). Important in Kenya was the contrast between age groups in favouring completely different packaging styles which means for the processors that they can only reach one age group when they design their packaging in a certain way.

Consumers' feedback was quite important for processors as they changed e.g. the size of their sales unit based on feedback although it was unclear how the feedback reached them. At the same time processors did not want their product to be "cheap looking" and for this reason changed the packaging type to fit the content. While the interviewed consumers were in general not willing to pay more for the packaging, they accepted higher prices when the appearance or the convenience was improved.

## STUDY LIMITATIONS

Limitations in this study include the fact that focus groups and key informant interviews are not representative of the whole population of interest, i.e. the results are not generalizable. Some concepts such as "sustainability", "processed FVs", and even "packaging" were found to have different understandings and interpretations. However, the projection technique, by showing participants the packages of interest eliminated the misunderstanding about "packaging" and "processed FVs" but not about "sustainability".

## CONCLUSIONS AND RECOMMENDATIONS

The issues of "packaging material" of fruit and vegetable products and "communication" on the packaging were identified as key issues about which consumers and processors had different views and concerns. Different views about sustainable packaging included i) the different understanding of the term "sustainable" being either "environmentally friendly" or "durable"; ii) different meanings regarding the term "bio-degradable"; iii) the re-use of packaging in general was seen as a "practical" and normal thing to do, not necessarily as "sustainable", although this is what the LCA shows; and iv) the issues and understandings of being "disposable", "recyclable" and "reusable".

There were no clear suggestions for one "best" packaging option in Kenya and EAC in general for the four different categories of FV products, yet, packages made from plastic are currently the most common for all FV product types, accessible and to some extent most preferred ones. From an LCA for the four product

categories it was learned that next to plastic bottles and jars which are at least once re-used, also craft paper for dried powders and light glass jars for sauces seemed to be the best options in terms of sustainability.

The challenge for sustainable packaging appears to be how to communicate to stakeholders the concepts of sustainability and its benefits for potential consumers. Although challenges exist, packaging can be improved to increase the sustainability while at the same time not compromising on design and convenience. In the light of the plastic bag ban, more alternatives should be sought and suggestions and guidelines should be given by the corresponding authorities. In particular, making a recycling system for plastics as well as sources for biodegradable packaging alternatives locally available are key issues in East Africa.

Increased knowledge about stakeholders' views on packaging is important for understanding packaging industry's problems and the potential to develop safe and attractive products and packaging. Implementation of the findings presented here can act as a first step in improving food – and especially fruit and vegetable – packaging practices in East Africa.

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