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Research Application Summary

Post-harvest handling, safety and nutritional contribution of cassava in coastal Kenya

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Abstract

Post- harvest losses is still a common challenge in most African countries. At the Kenyan coast, farmers are faced with the challenge of handling cassava produce due to the short shelf-life of the product. Due to inadequate knowledge by the farmers and the low capacity building with regards to cassava production, utilisation and commercialisation the rate of post-harvest losses of the crop are still high. Cassava a starch rich root crop has been grown as a food security crop but due to the limited nutritional composition of the crop, there is need to increase nutritional composition of the crop through bio-fortification and enrichment with crops which are high in protein and macro nutrients and micro nutrients. The levels of vitamins, protein and zinc thus need to be increased. The problem of cyanogenic glycosides equally needs monitoring with the development of processing methods to ensure the levels are reduced to tolerable levels for consumption. Cassava is utilized both at the farm level as food and in the industries as source of commercial starch. With continued bio-diversification of the crop comes new product lines thus economic empowerment and thus potential of improving on the farmers' livelihood. To spur the utilization of the crop farmers have small enterprise shops where crisps, fried roots and flours are sold. The farmers prefer a mixture of methods such as peeling, soaking water, sundrying, oven drying as methods of reducing the cyanide levels.

Key words: Cassava, cyanide, Kenya, nutritional, post-harvest, products, utilization

Résumé

Les pertes après récolte sont toujours un défi commun dans la plupart des pays africains. Sur la côte kenyane, les agriculteurs sont confrontés au défi de manipuler les produits à base de manioc en raison de la courte durée de conservation du produit. En raison de l'insuffisance des connaissances des agriculteurs et du faible renforcement des capacités en matière de production, d'utilisation et de commercialisation du manioc, le taux de pertes de récolte après récolte est encore élevé. Le manioc, une racine riche en amidon, a été cultivé comme culture de sécurité alimentaire, mais en raison de la composition nutritionnelle limitée de la culture, il est nécessaire d'augmenter la composition nutritionnelle de la culture par la bio-fortification et l'enrichissement avec des cultures riches en protéines et en macro nutriments et micro nutriments. Les niveaux de vitamines, de protéines et de zinc doivent donc être augmentés. Le problème des glycosides cyanogéniques doit également être surveillé avec le développement de méthodes de traitement pour garantir que les niveaux soient réduits à des niveaux tolérables pour la consommation. Le manioc est utilisé à la fois au niveau de la ferme comme aliment et dans les industries comme source d'amidon commercial. Avec la bio-diversification continue de la culture, de nouvelles gammes de produits entraînent une autonomisation économique et donc un potentiel d'amélioration des moyens de subsistance des agriculteurs. Pour stimuler l'utilisation des cultures, les agriculteurs ont de petites boutiques où l'on vend des chips, des racines frites et des farines. Les agriculteurs préfèrent un mélange de méthodes telles que l'épluchage, le trempage de l'eau, le divers, le séchage au four comme méthodes de réduction des niveaux de cyanure.

Mots-clés: manioc, cyanure, Kenya, nutrition, post-récolte, produits, utilisation

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Introduction

Cassava is a root crop cultivated in most tropical and subtropical climates. It is a food security crop that has been utilised globally as a staple food in most households (Adeola *et al.,* 2017). Over the years, there has been an upsurge in global demand for healthy food products in a bid to ensure food security in most developing countries such as Kenya (Bennett, 2015). This has subsequently led to the cultivation of drought-resistant crops such as cassava. However, there have been dire challenges as far as post-harvest handling and safety of cassava is concerned. This has been attributed by most scholars to the rapid physiological deterioration of cassava root post-harvest (Bennett, 2015).

The high perishability has prompted the need for prompt consumption and increased diversification of cassava. Studies have shown that processing of cassava root into various forms such as starch, gari, fufu and high-quality flour enhances long-term storage and stability (Okhankhuele *et al.,* 2017). Cassava is a valued food energy source in most developing counties hence the need to study the role of optimum post-harvest handling, safety and nutritional value (Okhankhuele *et al.,* 2017). This research paper critically reviews post-harvest handling, safety and nutritional contribution of cassava root. Besides, the research paper also pays attention to the challenges that small-scale farmers face such as inadequate cuttings and various factors that limit full cassava utilisation. The study also reviews diverse climatic cassava crop adaptability, current utilisation of the product and the extent of bio-diversification of the product, a case study of coastal Kenya.

Cassava production

Cassava is one of the drought-tolerant crops which is highly rich in starch. The crop can thrive in high altitude regions as well as the low lands. The crop is grown globally, Thailand and Brazil being amongst the leading world producers (Bennett, 2015). In Africa, the crop is highly commercialized in the western countries such as Nigeria and thus explaining the great production exhibited in those regions (Okhankhuele *et al.,* 2017). In East Africa, Uganda is one of the leading producers. In Kenya, the crop is majorly grown along the Western parts and the Coastal regions that are Kilifi, Taita-Taveta and Kwale counties (Mwang'ombe and Mbugua, 2013) Considering the high resilience of the crop, rainfall as low as 400 mm per annum can sustain its production. Its ability to survive at relatively high temperatures of 27-30 oC makes the crop a staple food for the coastal population (Mutai *et al.,* 2017).

Through research, there are improved varieties that are more resistant to drought and are equally high yielding. According to KALRO Mtwapa, improved varieties such as Tajirika and Shibe have made enormous contribution towards the move to upscale cassava production (KALRO, 2018) The varieties can yield an average of 13-18 kg of roots per plant. However, the farmers are slow to adopt the new varieties due to challenges such as lack of market, lack of enough capital and inadequate capacity building (Mutai *et al.,* 2017). The high rate of perishability of the roots equally discourages the farmers from upscaling the production of cassava (Talsma and Mwangi, 2013) The farmers thus resort to growing the local varieties that have been inherited since time immemorial. One such leading local variety is Kibandameno. This variety which is low yielding and highly susceptible to diseases such as Cassava Brown Streak Disease, Cassava Mosaic Disease (Mutai *et al.,* 2017). However, most farmers due to scanty knowledge, attributed the diseases to indicators of late harvest or poor weather and high water content in the soil (Mwang'ombe and Mbugua, 2013).

The cassava crop is majorly grown as a food security crop (Abong *et al.,* 2016). Most of the cassava farming along the coastal region is done on small-scale farms, and the crop is intercropped with other legumes and cereals (Joachim, 2015). Due to the drought that occurred in the region between 2016 and 2017, there are inadequate cuttings to plant and thus the crop is grown as a border crop or few stems grown at the gardens in the homestead. Cassava does well in most of the soils and does not require much water for its production. The crop is majorly intercropped with Maize, cowpeas, pigeon peas and with bananas and tomatoes in Taveta sub-county.

Post-harvest handling

Cassava root is a rich source of starch and is highly utilised as a food security crop along the Kenyan coastal region. The crop is quite adaptive to the region and thus grown on a small scale by the farmers. The crop, however, has a great set back that affects its utilisation. It is highly perishable with a shelf life of about 3-5 days depending on the mode of harvesting, variety and post-harvest handling and processing (Abong *et al.,* 2016) The crop is not highly processed since most of its production is done by farmers who are relatively aged with an approximation average of near 40 years (Abong *et al.,* 2016). The level of commercialisation of the crop is quite low despite attempts of promotion by the Kenyan government as well as interested organisations and interested research individuals (Apichai and Kaemwich, 2015).

After harvesting of the crop, most farmers are faced with the problem of high cassava perishability and thus are forced to do prompt consumption, and thus most harvesting is done as a piecemeal. A section of the farmers who do piecemeal harvesting are equally faced with the problem of high perishability (Abong *et al.,* 2016); both in soil storage of the crop at home and leaving part of the harvest in the garden can only preserve the crop for at most 5-7 days and thus the farmer has a maximum of 7 days to utilize the entire product. The high perishability of the crop has motivated the young entrepreneurs to exploit the utilisation of the crop to make a living (Mulu-Mutuku *et al.,* 2013) Currently, at the Kenyan coast, apart from the traditional dried chips, the entrepreneurs have diversified the crop into various uses which is not limited to cassava flour and cassava composite flourandcrisps (Kachiri-coastal kenya local name). The processing of cassava is majorly done by the women and since the women are hardly the decision makers of the household, the level of processing of cassava is still quite low (Mulu-Mutuku *et al.,* 2013).

Due to the continued recycling of cassava root cuttings (seeds), the rate of plants re-infection is quite high with diseases such as Cassava brown steak disease (CBSD) being highly prevalent (Mwang'ombe *et al.,* 2013). The farmers are equally not highly educated to harvest the crops in time (Abong *et al.,* 2016). Thus, farmers in the region experience high yield losses due to the disease coupled with the impacts of late harvesting. The farmers are therefore forced to utilise the affected roots as animal feed or dried as chips and milled into flour in seasons of bumper harvest and season of scarcity, respectively.

Cassava storage after harvesting is a challenge to the farmers as most of the process is done by small-scale processors at the farm level (Abong *et al.,* 2016). The small-scale farmers exhibit adequate capacity building in the production process. The level of expertise is quite low, and the structures are either expensive to purchase, or inadequate sensitisation is done. Most of the cassava products are stored in gunny bags and are kept on the floor of the houses or designated stores with other crops.one of the major setbacks that the farmers experience while solving post-harvest losses in cassava is the high rate of pest infestation of cassava chips from other cereals and grains stored in the same rooms (Mulu-Mutuku *et al.,* 2013).

Utilization of cassava and cassava products

Traditionally cassava is grown as a food security crop that rescues farmers in the times of scarcity (Mbere and Talsma, 2015). At the household level, the crop is grossly consumed as a meal either as raw cassava roots or boiled roots (Adeola *et al.,* 2017). And in attempts to increase the nutritional composition of the meals, farmers have incorporated other protein-rich crops such as beans and cowpea to make a meal termed Kimanga, a traditional dish along the Kenyan coastal region. The farmers' solution to high perishability problem is through processing of the fresh roots into cassava chips and flours. Cassava flours are either consumed purely or mixed with maize as a traditional fashion although this may not be of much nutritional value (Nginya *et al.,* 2017) The Nigerian Government and now both Kenya and Uganda have a policy that makes it mandatory to blend cassava and wheat flours for (Okhankhuele *et al.,* 2017). Through the Olesegun Obasanjo movement in Nigeria, the country currently incorporates up to 40% cassava in the baking flours (Adeola *et al.,* 2017).

In attempts to spur the production of the crop, the rate of commercialization of cassava is on the rise. The production of commercial starch is one of the product lines that have increased the production of cassava. The industrial starch which is majorly used as a stabiliser, i.e. the resistant starch has been effective in stabilizing yoghurt (Mwizerwa *et al.,* 2017). In the industry, one of the developing product lines is the utilization of starch to produce bacterial cultures. The step has been achieved through the utilisation of cassava pulp for succination products by metabolically engineered *E.coli* (Apichai and Kaemwich, 2015).

Cassava has extensively been utilized as animal feed both at the farm level and at the industrial levels. Most of the farmers would feed their livestock as well as poultry with the cassava peels and even the CBMD affected roots. At the industrial level, feed manufactured from cassava is one of the product lines that have contributed to employment. Through increased product diversification, cassava has been used in the production of Biofuel (Seksan and Paritta, 2013)). In Thailand, biofuel production has been greatly exploited and thus the motivation for Thailand to be a leading global producer of cassava (Seksan and Paritta, 2013).

Nutritional contribution of cassava

Cassava roots have extensively been consumed as a food security crop and a good source of energy for both children and adults (Nginya *et al.,* 2015). The high starch-rich food is, however, relatively low in other nutrients such as vitamins and proteins and thus the need to increase enrichment as well as bio-fortification of the cassava roots. The low levels of nutrients of cassava roots call for dietary diversification (Talsma *et al.,* 2013). The cassava roots serve as a staple food along the Kenyan coastal regions and are one of the crops that rescues the farmers during the seasons of scarcity. The crop which is drought resistant hardly fails, and thus in most of the households, it is grown at the backyards as a food security crop and thus a food security source of nutrient to the farmers. The cassava roots have high levels of cyanogen glycosides which greatly limits the utilization of the roots (Gacheru *et al.,* 2015).

The cassava crop is extensively utilized for its leaves too. The cassava leaves are a rich source of vitamins, proteins and minerals and thus a complementary to the nutrient deficient roots (Latif and Müller, 2015). The leaves which are mostly consumed as vegetables and consumed with cassava flour makes the cassava crop a major nutrient source to the households along the Kenyan coastal regions. The leaves, however, have high anti-nutrients and cyanogenic glycoside which limits their utilization. The consumption of improperly cooked or processed leaves limits the use of the vegetables due to the high anti-nutrient contents (Latif and Müller, 2015).

In an attempt to solve the limiting factors of utilization of cassava and cassava roots, there is a continued attempt of bio-fortification of cassava roots with Vitamin A. However, due to the consumers' belief of Cassava being white, the acceptance of the orange-fleshed cassava remains a challenge to the consumers especially children (Talsma *et al.,* 2015). The anti-nutrients levels in cassava leaves are significantly reduced through detoxification of the leaves mainly by fermentation. Fermentation equally improves the bioavailability of the nutrients and thus contributing towards solving the problem of anti-nutrients in the leaves (Talsma *et al.,* 2013).

A study done by Lintone Albert on five cassava genotypes highlighted the nutritional composition of the crop to be as follows 9.2–12.3% moisture, 1.2–1.8% crude protein, 0.1–0.8% crude lipid, 1.5–3.5% crude fibre, 1.3–2.8% ash, 80.1–86.3% carbohydrate, 1406–1465 kJ 100 g 1DM and 95–135 mg g 1 of phytic acid. Mineral contents were 10.9–39.9, 15.2–32.3 and 9.3–54.1 mg g 1 for Ca, Mg and P, respectively, and 221–328, 4.7–25.8, 1.41–4.25, 0.29–1.73 and 1.2–4.44 mg g 1 for K, Na, Zn, Mn, Cu, and Fe, respectively. HCN content ranged from 8.33 to 28.8 mg HCN/kg dry weight basis (Linton, 2014).

Safety of cassava consumption

Cassava a staple food to a huge population of approximately 800 Million and a backbone of major industries such as biofuel and commercialized starch can be consumed raw or cooked or boiled and or as dried chips (Gacheru *et al.,* 2015). The levels of cyanogen glycosides are, however, quite high in the roots. Processing of cassava roots into varied products faces the same major challenge of high hydrogen cyanide (Gacheru *et al.,* 2015). The process is often done to reduce the levels of the toxic substances. Along the Kenyan coast, most homes utilise the cassava roots as food with a high rate of consumption being evident in the season of the scarcity of maize. The level of commercialisation of the product is on the increase and the rate of product bio-diversification needs an improvement The dried cassava chips, the raw cassava roots and the cassava crisps and cassava flour which are sold in small vendor open-air markets, as well as established shops, do have high levels of cyanogen glycosides as well as high aflatoxin levels. Through a study done by Gacheru *et al*. (2015) the levels of cyanogen compound in cassava was approximately 10 %. The levels indicate that even with the current processing of the cassava roots into crisps and flour the level of Hydrogen cyanide is still high and thus poses a safety concern to the consumers (Talsma and Mwangi, 2013).

Despite the high levels of cyanogen glycosides in the fresh roots at the farm level, plenty of the roots are still consumed raw. The next best alternatives of consumption of dried chips and flours still pose a significant safety concern to the consumers (Mwizerwa *et al.,* 2017). The level of aflatoxin in cassava flours like any other flour is high, and this can be attributed to high moisture content in the dried chips (ref). The level of moisture content in the dried chips while in storage is high enough to sustain the growth of mold and yeast, and these are reported to be of safety concerns as the metabolites may be injurious to human health. The evident green color of the chips is an indicator of high mold levels. Although the milled flours are quite white, the desired property by most of the consumers, the flour are still of high safety concern to the health of the consumers (Gacheru *et al.,* 2015). The high levels are an indicator of the need for further intensive and comprehensive processing methods or procedures to reduce further the toxic levels of the cassava flours. Although the rate of cassava poisoning are on the decrease, the minor side effect, which are in most cases ignored by consumers, are still evident. Constipation, mild headaches, anxiety and seizures are still evident. The levels of cyanide in cassava products still need further reductions to ensure minimal ill health effects on the consumers.

Reduction of cyanide in cassava

In attempts to reduce the levels of cyanide to tolerable levels and reduce the effects of cyanogenic glycosides, varied processing procedures have been established. To ensure maximum reduction of the levels of cyanide hurdle technology has been used. At the farm level farmers would prefer peeling of the cassava roots to reduce the level of cyanides. More elaborate procedures entails, peeling, washing , drying and fermentation. A combination of all the mentioned procedures reduces the level of cyanide to near recommended levels. The use of sun drying instead of oven drying is preferred as it less costly and efficient. Some of the farmers would prefer soaking of the root tubers and pouring the water while preparing the meals, especially the vegetables. Soaking of cassava roots and leaves then pounding before preparation equally reduces the level of cyanide in the vegetables.

Conclusion

Post-harvest handling of cassava and cassava products is still a challenge to the farmers. There is still much waste due to inadequate capacity building and inadequate knowledge by the famers. The low rate of commercialization of the crop discourages the small scale farmers who are majorly women from up scaling cassava production. The crop is quite rich in starch but deficient on other nutrients such as protein and macro nutrients, thus the need to increase bio-fortification and nutrient enrichment of the product. Cassava and cassava products still have high levels of cyanogenic glycosides, the toxic substances pose nutritional safety concerns to the consumers. There is no definite protocol for reduction of the toxic levels in cassava and cassava products. Although there are attempts to reduce the cyanide levels in cassava, the most efficient processing procedures are not documented for use at the farm level. Cassava is utilized both at the household level as source of food and at the industry level for production of resistant starch and biofuel.

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