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## QUALITY AND SAFETY CHARACTERISTICS OF CASSAVA CRISPS SOLD IN URBAN KENYA

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### ABSTRACT

Cassava (*Manihot esculenta* Crantz) crisps are increasingly popular in Kenya's urban areas. Crisps are popularly consumed as snacks outside homes and in-between meals. However, limited information on the quality and safety of the crisps is available in the country. This study sought to characterise the quality and safety in terms of cyanide levels of cassava crisps commercially traded in Mombasa and Nairobi areas in Kenya. Samples of six commercially traded crisp brands were collected in duplicates, from vendors and supermarkets; and evaluated for moisture, oil, cyanide and sodium chloride contents. Product colour and texture were also evaluated. There were significant differences among brand contents of moisture ( $P=0.0001$ ), oil ( $P<0.0001$ ) and cyanide content ( $P=0.026$ ). Levels of sodium chloride were, however, insignificant ( $P>0.07$ ). Moisture content ranged from 4.3 to 6.77%, oil content 19.17 to 30.68%; and cyanide and salt contents ranged 13.5 to 32.24 ppb and 2.3 to 2.7%, respectively. There were no significant differences ( $P>0.57$ ) in the texture, as well as in the yellowness ( $b^*$ ) parameter ( $P>0.137$ ). On the other hand, significant differences were observed on colour. Moisture and cyanide levels exceeded the statutory limits.

*Key Words:* Cyanide, *Manihot esculenta*, moisture, oil

### RÉSUMÉ

Le chips de manioc (*Manihot esculenta* Crantz) deviant de plus en plus populaire dans les zones urbaines du Kenya. Les chips son generalement consommées sous forme de gouter en dehors de la maison et au milieu de deux repas. Neanmoins, tres peu d'informations sont disponibles sur la qualite et l'hygiene des chips vendus au Kenya. Cette etude visait a faire le point de la qualite et de l'hygiene en terme de quantite de cyanure du manioc dans les chips commercializes dans les villes de Mombasa et Nairobi au Kenya. Des echantillons de six marques de chips commercializes ont ete collectes chez des vendeurs et supermarches, et ont ete evaluees pour leur taux d'humidite, d'huile, de cyanure et de chlorure de sodium. La couleur et la texture ont ete aussi evaluee. Des differences significatives ont ete observees dans les taux d'humidite ( $P=0,0001$ ), d'huile ( $P<0,0001$ ) et de cyanure ( $P=0,026$ ) d'une marque a une autre. Les taux de chlorure de sodium n'etait pas significativement differents ( $P>0,07$ ). les taux d'humidite varient de 4,3 a 6,77%, ceux d'huile de 19,17 a 30,68%; tandis que ceux de cyanure et de sel varient respectivement de 13,5 a 32,24 ppb et 2,3 a 2,7%. Aucune difference significative n'etait observee dans la texture ( $P>0,57$ ), ni dans l'inde de teinte jaune ( $b^*$ ) ( $P>0,137$ ). D'autre part, des differences significatives ont ete observees au niveau des couleurs. Les taux d'humidite et de cyanure depassaient les limites statutaires; d'ou de potentiel dangers pour la sante des populations.

*Mots Cles:* Cyanure, *Manihot esculenta*, humidite, huile

## INTRODUCTION

The contribution of cassava (*Manihot esculenta* Crantz) to food security and incomes for rural communities in sub-Saharan Africa, cannot be overemphasized (UNESC, 2007). However, due to its short post-harvest shelf-life, cassava roots need to be processed within 24 hours after harvest, to reduce losses. More stable products such as fermented and non-fermented flours, sun-dried chips, starches and culinary products have been made from cassava (Achacha, 2001). Highly stable fried crisps have, for instance, become important snacks, especially in major urban areas of Kenya, consumed by people of diverse backgrounds.

The quality of crisps depends on a number of factors, such as frying temperature, slice thickness and oil used (Abong' *et al.*, 2011). It is, however, not known to what extent there are quality and food safety variations in cassava crisps currently sold in urban centres of Kenya.

Depending on the variety, cassava contains varying amounts of cyanogenic glucosides that may pose serious health risks when consumed in high quantities (Wangari, 2013). Deep oil frying, just like other modes of processing, is known to reduce cyanogenic compounds (Brimer *et al.*, 2013). It is not known whether the crisps currently in the market have safe cyanide levels set by World Health Organisation (WHO) at  $<10 \text{ mg kg}^{-1}$  (FAO/WHO, 1991). This study was designed to assess quality characteristics as well as safety in terms of cyanide levels of cassava crisps commercially traded in urban Kenya.

## MATERIALS AND METHODS

**Study area and sampling.** A cross-sectional survey was undertaken in Mombasa and Nairobi Counties of Kenya, between February and April 2014. Mombasa and Nairobi were purposively selected due to the existence of a relatively large number of cassava farmers and notable processing activities, according to Abong' *et al.* (2015, unpublished). Since the quantity of cassava crisps could not be ascertained from any available information, exhaustive sampling of the different brands of crisps was carried out within the two counties, including purchases from retail outlets

and street processors. Six samples were purchased in duplicates of 100 g, and analysed for contents of cyanide, moisture, salt and oil; and colour and texture variations. Three brands of cassava crisps were purchased from Nairobi and Mombasa in each case.

**Laboratory analyses.** Moisture content was determined by drying in forced air oven at 105 °C. Oil content was determined by extraction of about 2.5 g of finely ground samples in Soxhlet apparatus for 8 hours, using analytical grade petroleum ether (boiling point 40-60 °C). Salt (NaCl) content was determined using the modified FAO/WHO method No. 16.209. Cyanide (HCN) levels were determined by distillation followed by alkaline titration according to AOAC (1980).

Cassava crisps colour was determined as described by Abong' *et al.* (2011), using the CIE Lab L\*, a\* and b\* scale, with L\* indicating lightness, a\* indicating redness and b\* indicating yellowness degree. Cassava crisps texture was measured using a texture analyser (Sun Rheometer Compac 100, Sun Scientific, Japan) as described by Abong' *et al.* (2011).

**Data analysis.** Data were subjected to analysis of variance (ANOVA) and means separated by Least Significant Difference using Statistical Analysis System (SAS Version 9). Pearson correlation was performed between moisture content and texture.

## RESULTS AND DISCUSSION

**Physical quality.** Moisture content ranged from 4.3 to 6.77% on a wet weight basis, with only two samples having the recommended moisture levels of less than 5% (EAS, 2010) (Fig. 1). There were significant differences in moisture content ( $P < 0.0001$ ) among crisps brands. On the other hand, there were no significant differences ( $P = 0.57$ ) in texture. Moisture content is essential for shelf-life of any food or feed. Most high moisture foods are highly perishable, given the fact that abundant water supports microbial growth and other chemical reactions (Sewald and DeVries, 2014). Low moisture foods such as crisps are known to be long lasting and, hence, a lower

limit of moisture set for similar products. High moisture contents in our samples may be a pointer to poor handling after processing; or inadequate dehydration during frying. Choice of packaging material may also contribute to high moisture content. Highly permeable material or improper sealing may contribute to higher moisture and, hence, lower shelf-life than anticipated (Tungangprateep and Jindal, 2004; Amadi and Adebola, 2008).

Crisps texture is determined by dry matter content and moisture contents, and processing parameters such as time and temperature (Kulchan, 2010). Low temperature exposes slices to longer frying time and, hence, affects texture; being soft if a variety is of low dry matter content

and, hence soggy product; or hard if a variety has high dry matter content. In our study, moisture content had a significant negative correlation ( $r=-0.22$ ,  $P>0.05$ ) with texture. Texture values were generally higher than potato crisps values reported by Abong' *et al.* (2010). This can be attributed to the differences in dry matter content that is generally high in cassava.

Crisps samples differed significantly in colour lightness ( $L^*$ ) ( $P=0.0016$ ) and redness ( $a^*$ ) ( $P=0.021$ ). There was, however, no significant difference ( $P=0.137$ ) in the yellowness ( $b^*$ ) (Table 1). The lightness parameter  $>70$  indicates that most of the crisps were white-cream; implying that the raw cassava colour changed to a small extent under the frying conditions. On the other

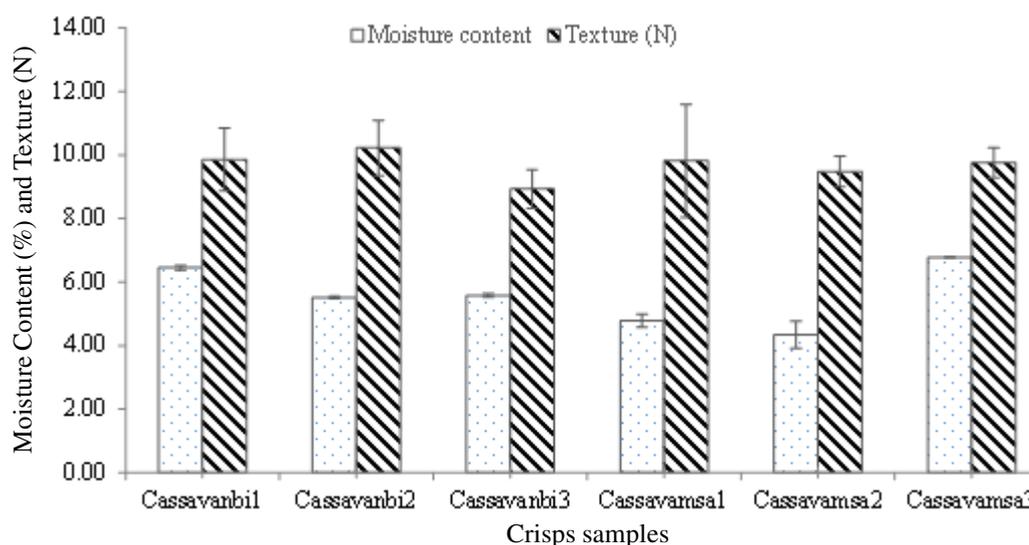


Figure 1. Moisture content (%) and texture (Newton force) of crisps samples from Nairobi and Mombasa Kenya. The bars indicate standard errors. Cassavanbi=samples from Nairobi, Cassavamsa=samples from mombasa.

TABLE 1. Colour characteristics of cassava crisps in Nairobi and Mombasa in Kenya

Sample	$L^*$	$a^*$	$b^*$
Cassavanbi1	71.45 ± 0.08	-0.53 ± 0.08	17.47 ± 0.08
Cassavanbi2	69.60 ± 1.96	-0.35 ± 0.12	17.68 ± 1.76
Cassavanbi3	71.13 ± 0.41	-0.52 ± 0.20	16.92 ± 1.27
Cassavamsa1	72.48 ± 1.05	-0.60 ± 0.40	14.78 ± 1.75
Cassavamsa2	74.70 ± 1.90	-0.87 ± 0.29	16.32 ± 1.95
Cassavamsa3	72.92 ± 3.53	-0.87 ± 0.43	15.97 ± 3.34

Values are means of duplicate measurements. Cassavanbi=samples from Nairobi, Cassavamsa=samples from mombasa.  $L^*$  = lightness,  $a^*$  = redness,  $b^*$  = yellowness

hand, the negative redness values suggest lack of browning or redness; hence crisps can be considered to have no or minimal acrylamide formation. At the same time, the yellowness parameter ( $b^*$ ) values obtained indicate yellowing to a certain degree. These results differ significantly from those of most potato crisps that usually display higher redness and yellowness values (Abong' *et al.*, 2010; Abong' *et al.*, 2011). This differences can be attributed to materials which have profound differences in chemical composition in terms of reducing sugars and amino acids.

**Chemical properties.** Significant differences were observed in oil ( $P<0.0001$ ) and cyanide contents ( $P=0.026$ ) (Fig. 2). The case of sodium chloride was, however, not significant ( $P=0.07$ ). Oil contents ranged from 19.17 to 30.68% and were mostly within the East African Standards requirement of not  $>30\%$  (EAS, 2010) and are relatively low compared to those of potatoes (Abong' *et al.*, 2010). All the tested samples had levels of cyanide (13.5 to 32.24 mg kg<sup>-1</sup>) above the recommended maximum value of 10 mg kg<sup>-1</sup>. The salt content ranged from 2.3 to 2.7%, all samples being above the recommended maximum level of 2% (EAS, 2010).

Oil content is an important processing parameter and its level in a food product has a number of implications. High oil contents could be due to more oil used as an ingredient, which is quite expensive in most cases (Abong' *et al.*, 2010). Due to consumption trends and nutrition knowledge, high oil products are also likely to be shunned by health conscious consumers, given the link between fat type and coronary diseases (Hu *et al.*, 1997). Large amounts of oil in food also negatively impacts on the shelf-life; reducing it due to possible oxidative rancidity (Wasowicz *et al.*, 2004). On the other hand, quite low oil content may lead to very hard and non-appealing crisps just as much as very high oil content leads to sogginess and, hence, product rejection. Processing parameters must, therefore, be chosen to optimise the oil content of an individual, product.

Cyanide in cassava is one of the key toxicants that hinder cassava utilisation (Akinpelu *et al.*, 2011). It occurs in both sweet and bitter varieties, in varying amounts (Wangari, 2013). Acute cyanide intoxication can lead to death if not treated; while chronic intoxication has been linked with goitre and nervous diseases (Rosling, 1994). Due to its lethal effect in humans, the World Health Organisation and many food standard setting

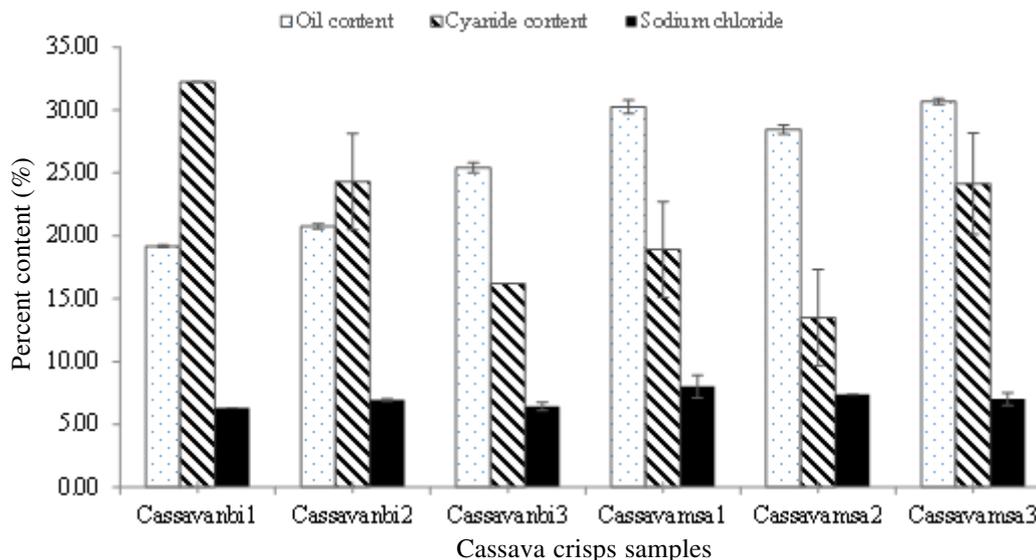


Figure 2. Residual Cyanide (mg/kg), oil (% wwb) and sodium chloride (% wwb) contents of cassava crisps from Nairobi and Mombasa Kenya. The bars indicate standard errors. Cassavanbi=samples from Nairobi, Cassavamsa=samples from mombasa.

organisations, such as the East African Community stipulate that cassava products ready for consumption should have less than 10 mg kg<sup>-1</sup> cyanide (EAS, 2010). None of the crisps sampled can, therefore, be considered safe for direct consumption as far as cyanide is concerned. However, this is also determined by the level of consumption of cassava crisps by an individual.

High salt consumption mainly through food, has been linked with high blood pressure and, hence stroke and other cardiovascular diseases (He and Whelton, 2001). Higher than the regulated salt levels in this study means that processors do not observe or are not aware of the required limits. Awareness creation among the processors may, therefore, be important towards safe and quality cassava crisps.

### CONCLUSION

Current cassava crisps in Nairobi and Mombasa generally have higher moisture, cyanide and sodium chloride contents than the values stipulated by the existing standards and may raise safety concerns. The quality of the cassava crisps, in terms of colour and texture, is not uniform, implying that processors do not have similar processing parameters. The requisite quality and safety of the products may be achieved through proper training of the processors on methods that reduce cyanide to acceptable levels.

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