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Microbial and Fungal Contamination of Processed Baobab Products in Kenya

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Abstract

There has been an increase in demand for baobab and baobab-derived foods recently as a result of expanding ready market both locally and internationally. This is following its approval as a novel food ingredient and a functional food by the EU and the UN. However, this demand has led to poor practices such as immature fruit harvesting, insufficient drying and unhygienic handling along the baobab value chain as the farmers rush into harvesting the baobab fruits before they are fully dried in order to meet the demand. These practices could lead to microbiologically unsafe and generally poor product quality. This study was conducted to investigate the microbial and fungal contamination levels in ready-to-eat baobab products from selected KEBS (Kenya Bureau of Standards) registered and unregistered baobab processors within specific counties in Kenya. Selected processed baobab products were sampled randomly from registered and unregistered processors and analyzed for the total aerobic count, Enterobacteriaceae, yeast and molds, moisture, and water activity. The moisture and water activity of baobab pulp and candies from registered processors was 11.78±0.53%, 0.649±0.71 and 11.30±0.33%, 0.699±0.89 respectively while those from unregistered processors had a moisture and water activity of 13.76±0.90%, 0.699±0.08 and 16.98±0.81, 0.716±0.26 respectively. In this study, baobab pulp from the registered processors had significantly (p=0.006, 0.004) lower Enterobacteriaceae and, yeast and molds loads (0.599±0.41 and 3.09±0.27 log $_{10}$ CFU/g, respectively) than pulp from unregistered processors (3.34±0.37 and 5.29±0.61 log $_{10}$ CFU/g, respectively). Similarly, the Enterobacteriaceae counts of candies from registered processors (non-detectable) were considerably lower (p=0.008) than those from unregistered processors (1.73±0.11 log $_{10}$ CFU/g). Microbial contamination in processed baobab products from the unregistered baobab processors could indicate an unhygienic processing environment while the fungal contamination may indicate poor postharvest handling, transport and storage conditions of baobab fruits along the baobab value chain. This study shows that standards play a key role in ensuring microbial safety of products.

Keywords: baobab, fungal, microbial quality, processed

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Introduction

Baobab tree populations are found abundantly traversing the Kenyan counties of Tharaka Nithi, Kitui, Makueni, Kilifi, Lamu, Kwale, and Taita Taveta. These are semi-arid lands which are hotspots for food and nutritional insecurity, as well as high poverty levels. Baobab fruit pulp has, in the recent past, gained interest in Europe and North America after being declared a novel food. This has led to increased demand and growth of market for baobab products in western and southern sub-Saharan Africa. While populations are gaining from its nutrition and economic potential, the baobab value-chain still faces unaddressed food safety concerns. The baobab fruit dries naturally, falling off the tree when completely mature and fully dried with a moisture content of about 11% (Chadare et al., 2009). However, market demand has been on the rise, and in an attempt to match the demand, farmers and middlemen have resorted to premature harvesting before the fruits are fully dried (Kaboré et al., 2011). Once the baobab pulp has been extracted from fruit, it is generally subjected to sun drying to ensure an acceptable moisture content. Sun drying is a slow process and is often carried out in open and unhygienic conditions (Trucksess & Scott, 2008). The final moisture content and hygienic handling conditions during processing determine the safety and degree of deterioration of these products (Rajkovic, Devlieghere, & Uyttendaele, 2016). Heretofore, the studies carried out on baobab have focused on the nutritional aspect, utilization as well as economics, market and trade. This study is aimed at determining the microbial and fungal contamination in selected processed baobab products in three Kenyan counties of Nairobi, Mombasa, and Kilifi.

Material and Methods

This study involved the use of two classification groups; the Kenya Bureau of Standards (KEBS) registered and the unregistered processors. Selected processed baobab products were sampled randomly from registered and unregistered processors and analyzed for the total aerobic count, Enterobacteriaceae, yeast and molds, moisture, and water activity.

Results and Discussion

Moisture content and water activity of baobab products

Baobab pulp and candies from the unregistered processors had relatively higher moisture content compared to the pulp and candies from the registered processors. The moisture content and water activity in baobab candies from KEBS unregistered processors (16.98±0.81%, 0.716±0.26) were significantly higher (P=0.015, 0.049) than those from the registered processors (11.30±0.33%, 0.699±0.89). This may well be credited to poor handling during processing, unsuitable packaging materials which may cause moisture reabsorption from the environment. It also be attributed to the lack of knowledge among unregistered baobab processors with respect to the existing drying convention and measures of handling (Ntuli et al., 2017). The moisture content of the baobab products is dependent on drying process, processing, transport, and storage conditions (Shimelis et al., 2019).

Microbial loads of baobab products

The microbial load of food products at the time of consumption is determined by production methods, extrinsic, intrinsic, and processing factors (European Commission, 2002). The Enterobacteriaceae and yeast and molds counts (3.34±0.37 $\log_{10}$ CFU/g and 5.2.9±0.61 $\log_{10}$ CFU/g) in baobab pulp from unregistered processors were significantly higher (p=0.006, p=0.004) than those from the registered processors (0.599±0.41 $\log_{10}$ CFU/g and 3.09±0.27 $\log_{10}$ CFU/g) respectively. The contamination of baobab pulp can be traced back to handling techniques at the farm and along the value chain (Jäckering et al., 2019).

Fig 1: **Drying of baobab**

Farmers harvest fruits that have not reached the optimum drying index to meet the ever-increasing baobab demand (Assogbadjo et al., 2018). This is followed by sun-drying of baobab fruits Fig 1, which is a slow process exposing the fruits to insects, dust, rain and other contaminants since it is done in the open (Sim´eon Bourdoux et al., 2016). Baobab pulp is not subjected to thermal processing, hence chemical, physical and biological hazards throughout the value chain, find their way into the end product.

Hygienic handling and processing is therefore mandatory to ensure safety of the product (Olaimat & Holley, 2012). The total aerobic count loads in pulp were greater in this study (4.29±0.43) than in studies on microbial analysis of freeze-dried fruits (Park et al., 2015) and commercial South African high-moisture dried fruits (Witthuhn et al., 2005).

Table 1: Intrinsic properties and microbial content of baobab products from KEBS registered and unregistered processors.

Product		Moisture content (%)	a_W	Log Tac	Log E	Log Y+M
Registered	**Baobab pulp**	11.78±0.53	0.649±0.71	4.29±0.43	0.599±0.41	3.09±0.27
Unregistered		13.76±0.90	0.699±0.08	3.67±0.40	3.34±0.37	5.29±0.61
p-value		0.146	0.279	0.04	0.006	0.004
Registered	**Baobab Candies**	11.30±0.33	0.699±0.89	5.37±0.39	0	3.60±0.93
Unregistered		16.98±0.81	0.716±0.26	3.59±0.31	1.73±0.11	3.79±0.33
p-value		0.009	0.03	0.70	0.008	0.50

Key: a_W= Water activity, SD = Standard deviation; Tac= total aerobic count; E= *Enterobacteriaceae* counts; YM= yeast and molds counts.

The highest yeast and mould counts were recorded in baobab pulp from unregistered processors in Mombasa and Kilifi 5.41±0.30 $\log_{10}$ CFU/g and 5.07±0.01 $\log_{10}$ CFU/g respectively. A similar trend was also observed in candies from unregistered processors in Mombasa and Kilifi 4.27±0.98 log10 CFU/g and 3.6±0.05 $\log_{10}$ CFU/g respectively. A study on the influence of temperature on microbial growth in food during storage revealed a similar trend, with high ambient temperatures increasing the multiplication of microorganisms (Raccach & Mellatdoust, 2007). Coastal temperatures in Kilifi and Mombasa counties can reach 29 and 32 degrees Celsius, respectively. Furthermore, both regions have a mean annual humidity of 74 percent, with the most humid months reaching around 80 percent, which is ideal for mould growth. Baobab traders in such high-humidity, high-temperature places may be at a disadvantage if they are unable to control water activity and moisture content.

Besides, the plastic bags used to package baobab candies and most of pulp from the unregistered processors sector may not be able to keep moisture-laden air out. This renders the baobab pulp and candies susceptible to moisture absorption which favours yeast and mould growth. Fungal and bacterial contamination is not entirely brought by the temperature and humidity, some steps in the baobab value chain predispose baobab fruits to direct bacterial and fungal infection. The main reservoir for fungal species, including mycotoxin-producing fungus, is soil (Mamo et al., 2020). Handling procedures are done in the open on farms or at collection centres, where these bacteria and fungi might invade baobab fruits during cracking and drying. Additionally, policies for the safe transportation of food goods are not enforced, so baobab pulp is delivered using any available transportation truck that offers low-cost services. This makes the baobab pulp susceptible to fungal infection in the environment (Aristil et al., 2020).

Table 2: Microbial content of baobab products from different regions

Sample	Area	Log Tac	Log E	Log Y+M
		Baobab Pulp		
Registered	Nrb	4.41±.98	0.5±1.2	3.56±1.1
	Msa	4.17±.04	0	0
	Kilifi	3.84±0	2±0	3.62±.21
Unregistered	Msa	5.37±.28	2.99±2.3	5.41±.30
	Kilifi	3.99±.21	3.33±.11	5.07±.01
		Baobab Candies		
Registered	Nrb	3.77±.15	0	3.54±.92
Unregistered	Kilifi	4.19±.81	2.11±2.5	4.27±.98
	Msa	2.37±.10	0	3.60±.05
	Nrb	3.38±.51	2.37±.08	3.25±.52

Tac- total aerobic count, E- *Enterobacteriaceae* counts, Y+M yeast and molds, Nrb – Nairobi, Msa –Mombasa.

Conclusions and Outlook

In conclusion, products from unlicensed baobab processors had the greatest levels of microbial contamination in terms of Enterobacteriaceae and TAC, which could be linked to unsanitary processing conditions. The findings of this study point to unsanitary postharvest practices across the baobab value chain as a source of contamination in baobab pulp and candies. Remedial procedures such as training on good hygiene and good manufacturing techniques, as well as Hazard Analysis Critical Control Points (HACCP) should be done to assure the safety of dried baobab fruits and baobab products along the baobab value chain (Perera, 2007).

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