Chapter 1

Introductory Chapter: Cassava as a Staple Food

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1. Introduction

Cassava (*Manihot esculenta* Crantz) has been used as a staple food of many nations. It is also known as manioc, yucca and tapioca. Its origins lie in Latin America, where it was discovered by the indigenous Indian population more than 4000 years ago [1]. After its discovery by the European traders who came to Central America, the crop was taken to Africa as well as Asia for food security purposes and for the extraction of starch [1]. The plant can be grown throughout the year and is known to exist under severe climates, being particularly suited to conditions of low nutrient availability and able to survive drought [2]. Its tuber—the swollen root of the plant—is the most popular form of consumption, although the leaves are also consumed at times for medicinal purposes.

Cassava has the greatest conversion in terms of transforming solar energy into soluble carbohydrates per unit of area [3]. Among the starchy staples, cassava gives a carbohydrate production that is about 40% higher than rice and 25% more than maize [3]. Cassava also consists of essential micronutrients, such as vitamins A, B and C, iron and Zinc, even though it is considered not having a limited nutritional value [4]. It is a major source of carbohydrate for many populations, and it is the third largest source of carbohydrate in the world with Africa being the largest centre of production [4]. Cassava is increasingly popular with African farmers because of its agricultural advantages and potential to feed rapidly increasing populations. Nigeria is the largest producer of cassava out of all the African countries [5]. It is the third largest producer of cassava in the world after Brazil and almost double the production of Indonesia and Thailand [6]. It is noteworthy in this aspect that households under stress from HIV/AIDS are switching from high-input to low-input farming systems that involve cassava [7]. With these developments, cassava has undoubtedly been touted as one of the major crops around the world as a source of income as well as for food security purposes.

Bearing these in mind, this book primarily focuses on the contemporary importance of cassava as a crop that requires biotechnological interventions, improvements of postharvest management and farming practices. The subsequent subtitles in this introductory chapter provide brief overviews of aspects which may or may not be covered in the content chapters, so that the voids and gaps are filled.

2. Cassava processing

Freshly harvested cassava roots start deteriorating almost immediately after harvest. This is due to its high moisture content. Thus, the best form of preservation of cassava is drying into pellets or chips or processing into flour. The traditional methods of processing cassava roots into various types of food have been adapted to suit the many attributes of the plant such as root yield, spoilage, cyanide content, nutrient content and process ability [8]. Nevertheless, with increasing populations, indigenous methods of cultivation and processing of cassava have been transformed by modern scientific knowledge for use in industrial operations [8]. In this aspect, mechanization of cassava processing plays a pivotal role in removing the negative attributes of the traditional processing techniques and promoting timely large-scale processing of the tubers in hygienic environments [6].

Cassava processing operations are often preceded by peeling, and for this task, many models and mechanisms have been developed throughout the years [9, 10]. Apart from the peelers, various types of cassava-grating machines have also been developed [11, 12]. Other unit operations involved in cassava processing include dewatering of cassava pulp (mash), drying and frying, which are still majorly carried out manually [13, 14]. There are several factors nevertheless, to be considered before the usage and implication of technical devices for these unit operations. The survey by Quaye et al. [15] in Ghana revealed the following major aspects and considerations for adopting a new cassava processing technology: (1) affordability of the technologies in term of cost implication and profit margin, (2) efficiency of the machine, (3) labour required to operate the machine and (4) simplicity.

3. Cassava products

A wide range of products can be made from cassava, although it is commonly used as raw material for the food industry. The freshly peeled tubers are eaten as a vegetable after boiling or roasting. When boiled and pounded into a paste, the tubers are often added to soups and stews—which is called 'Fufu' in Nigeria [1]. It can also be consumed as sundried chips, which is known as 'Kokonte' in West Africa, and consumed after cooking or being ground into flour. Cassava flour is used in the preparation of bread, biscuits, confectionary, pasta and couscous-like products and in the production of adhesives [1]. The fermentation of cassava brings a new line of food products altogether.

Fermentation, either naturally or with selected microbial inoculums, has been extensively used to enhance the nutrient potentials of cassava and its by-products both for human and livestock consumption [16]. For the fermentation of cassava, two popular fermentation techniques, namely, the liquid substrate or submerged fermentation technique and the solid substrate fermentation are used [16]. The cassava roots, peels, leaves and pomace are the typically used parts of the plant, which are subjected to fermentation. The fermentation process has also played a significant role in the nutritional enhancement of the agro-industrial by-products generated through the harvesting and processing of cassava roots.

Apart from the food industry, cassava starch is used for textiles and the paper industry, and in the manufacture of plywood and veneer adhesives and glucose and dextrin syrups. Through fermentation, it can also be used for alcohol production, and as a waste material, it can be processed to biogas [17].

4. Nutritive and anti-nutritive properties of cassava

The composition of cassava, and thus its nutritional properties, depends on the specific tissue (root or leaf) being consumed. These aspects in turn, depend on several factors, such as geographic location, variety, age of the plant and environmental conditions [18]. Cassava roots are typically known to be the primary source of energy [11]. The leaves on the other hand provide protein, vitamins and minerals [19]. However, cassava roots and leaves are deficient in the sulphur-containing amino acids, methionine and cysteine, and some nutrients are not optimally distributed within the rest of the plant's physiology [20].

Cassava also contains its own share of anti-nutrients, which have either positive or negative effects on the health, depending upon the amount of the component being ingested [21]. They basically interfere with the digestibility and uptake of some nutrients. Nevertheless, depending on the amount consumed, these substances can also bring benefits to humans. Cyanide is the most toxic factor restricting the consumption of cassava roots and leaves. Several health disorders and diseases have been reported in cassava-eating populations, owing to the presence of improperly processed cyanide [18]. The consumption of lower cyanide amounts is not lethal but long-term intake could cause severe health problems such as tropical neuropathy [22]. The nitrate content in cassava leaves ranges from 43 to 310 mg/100 g DM (dry matter) [21]. Cassava-eating populations are naturally exposed to high amounts of cyanide, nitrates and nitrites—chemical compounds which are known to contribute to the risk of developing stomach cancer [22]. Cassava-eating individuals tend to have a high amount of thiocyanate in the stomach due to cyanide detoxification by the body, which may catalyse the formation of carcinogenic nitrosamines [18, 21, 22].

5. Cassava for ensuring food security

Food security has become a growing concern around the world. Coupled with inadequate caloric intake, food insecurity is a major cause of death and morbidity in the world, particularly in developing countries [23]. The major staples of rice, wheat, maize and soybean are now recognized as not being the complete solution to world food security [24]. Diversification of farming of agricultural crops and food production has been recognized as a need, extending towards coarse grains, roots and tubers, pulses and oilseeds [24]. In this aspect, cassava has been recognized as a crop that is able to address the global food security needs around the world. It has been biotechnologically manipulated for better growth and higher crop production for this purpose.

Good yield progress has been achieved for cassava crops after relatively few decades of genetic improvement compared with other staples, which are being bred and harvested for food security purposes [24]. Adoption of new varieties of cassava has been strong in Thailand, Vietnam and Nigeria [25–27]. Given the current practice of minimal use of inputs, great scope also exists for closing the large yield gap of cassava production through better agronomy [24]. For this purpose, commercialisation of the cassava cultivation in Sub-Saharan Africa should help close the gap by providing stimulus for farmers to invest in more inputs [28].

6. Postharvest deterioration of cassava roots

Given the marginal environments where cassava is grown, its postharvest processing is frequently affected by large distances to the processing centres and deficient transport infrastructure, specifically roads [29]. Cassava roots are also bulky, containing approximately 65% water, which leads extensively to the postharvest physiological deterioration (PPD) [29]. The short shelf life of the roots hinders many of the marketing options by increasing the likelihood of losses and thereby increasing the overall marketing costs [29]. In addition, the access to urban markets and processing facilities is restricted to production sites that are relatively close to them [30, 31].

Research to date concerning the study of PPD has mostly focused on biochemical signalling events several hours after harvest [32]. Upon examination of physiological and biochemical changes occurring after cassava root detachment, changes in the nature and type of volatile compounds emitted, secondary metabolites accumulated, and changes in the expression of key genes in reactive oxygen species (ROS) turnover had been primarily observed [33, 34]. Nevertheless, based on combined proteomics data, enzymatic activities, and lipid peroxidation assays, Vanderschuren et al. for instance [35] have identified glutathione peroxidase as a candidate for reducing PPD. Further, in this study, transgenic cassava overexpressing a cytosolic glutathione peroxidase in storage roots showed delayed PPD and reduced lipid peroxidation as well as decreased hydrogen peroxide accumulation [35].

7. Conclusions

Cassava continues to grow as a crop of importance around the world for curbing food security issues as well as a means of income and livelihood. While its versatility as not only a food source for humans but also for animals, as well as a means of biofuel has been recognized, further research needs to be targeted towards the biofortification of cassava, so that the plant can be advocated as a contributor of essential vitamins and minerals.

As a crop which is heavily subjected to biotechnological interventions, transgenic interferences looking into the clonal propagation of crops have the potential to accelerate product development and address genetic constraints which may impede traditional breeding approaches. This could be considered as a vital approach for promoting cassava as a means of preventing food security issues. To be successful, however, as highlighted by Vanderschuren et al. [35], crop biofortification programs must develop integrated management practices by which molecular biologists, breeders, agronomists, nutritionists, educators, economists, farmers and consumers are all engaged in product development and delivery.

As an objective of this book, it is hoped that readers would see the importance of cassava, its research and cultivation aspects as a vital means of livelihood for feeding the global population, which is likely to grow in the subsequent years. As a crop, it has many applications, thus, having the ability to generate revenue and income for developing countries. It is hoped that cultivation of this crop will be seen as a positive means of agriculture, and its existing agricultural, postharvest and processing issues will gain rapid attention for remediation.

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