INTERNATIONAL JOUNAL OF: ENGINEERING RESEARCH AND TECHNOLOGY

TIMBOU-AFRICA ACADEMIC PUBLICATIONS
INTERNATIONAL JOURNAL, AUGUST, 2022 EDITIONS
VOL. 10 NO. 5 ISSN: 2707-5654

CASSAVA PRODUCTION, PROCESSING AND UTILIZATION IN NIGERIA: A REVIEW

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ABSTRACT

Food is any substance consumed to provide nutritional support for an organism. Food is usually meant for human beings, animals and plants and should contain the essential nutrients such as carbohydrates, fats, proteins, vitamins or minerals. Food substances are digested by an organism and assimilated by the organism's cells to provide

Introduction

Background

Food is any substance consumed to provide nutritional support for an organism. It is usually meant for human beings, animals and plants and should contain the essential nutrients such as carbohydrates, fats, proteins, vitamins or minerals. Food substances are digested by an organism and assimilated by the organism's cells to provide energy. However, preservation of food remains a big problem affecting many crops including cassava.

energy. However, preservation of food remains a big problem affecting many crops including cassava. This study is aimed at reviewing the level of cassava production, processing and utilization in Nigeria.Cassava (Manihot esculenta crantz) is a starchy tuberous root crop belonging to the family of Euphurbiaceac. After rice, sugarcane, and maize, it is the fourth source of dietary energy in the tropical region and the ninth globally. Nigeria is currently the largest producer of cassava in the world with an annual output of over 34 million tons of tuberous roots.Indeed, it is grown by almost every household in Nigeria. Some of the principal recommended cultivated varieties in Nigeria include; TME419, TMS90257, TMS 91934, TMS81/00110, TMS82/0066. Machines for cassava processing are made to replace the hand-operated method (manual) and to increase output to attain the required demand for food, fiber, and materials. Suitable mechanization and automation are vitally needed to achieve the desired end product which include among others the following: garri, flour, apku, (fufu), dan wake, chips, starch, bread. Cassava performs five main roles: Famine reserve, Rural staple food, Cash crop for urban consumption, Industrial raw materials and Foreign exchange. Constraints in cassava production include a wide range of technical, institutional and socioeconomic factors. These include pests and diseases, agronomic problems, land degradation, shortage of planting materials, food policy changes, access to markets, limited processing options and inefficient/ ineffective extension delivery systems. Cassava is a major source of carbohydrates in human diet. It is widely cultivated and serves as a major source of income in countries like Nigeria, Brazil, India and most West African countries. The tubers of cassava cannot be stored longer after harvest before decaying. Due to this short storage period of the tubers, cassava tubers are further processed into other forms to enhance its storage and to serve other purposes.

KEYWORDS: Cassava, Garri, Production, Processing, Utilization

Cassava (*Manihot esculenta crantz*) is a starchy tuberous root crop belonging to the family of Euphurbiaceac (United State Department of Agriculture, 2018). After rice, sugarcane, and maize, it is the fourth source of dietary energy in the tropical region and the ninth globally. It is also the staple food of roughly 800 million people worldwide in the developing countries, cassava is considered as drought, war and famine crop (Burns *et. al.,* 2010). It is commonly grown by low-income and smallholder farmers because of its tolerance to low soil fertilizer, drought and most pest and diseases (Howeler, *et. al.,* 2013). Thus, dependence on this crop will expectedly rise in the coming years with aggravation of climate change.

A major limitation of cassava is its rapid post- harvest physiological deterioration. It should be processed immediately after harvest because it is highly perishable. Deterioration normally starts within 48 to 72 hours after it is taken from the ground (Smith,*et. al.,* 1994). Hence, it is crucial that the tubers are processed as early as possible (Ajao,*et. al.,* 2013). Moreover, processing the cassava decreases the cyanide content which is poisonous. Consequently, this prolongs the products shelf life, reduces post-harvest losses, and prevent contamination of the products which will convert the crop to a safer and more merchantable form (Doydora,*et. al.,* 2017). In rural areas, manual processing of cassava is practical. These traditional ways of grating cassava are done by manually rubbing the peeled tubers against a roughened surface of galvanized mild steel on a wood or metal frame. Manual grating is tedious, time consuming and usually result in injuries to the fingers of the operator. Furthermore, the manual grating of cassava leads to non-uniform quality products. The quality can differ from one operator to another, and even with the same person (Jekayinfa, *et. al.,* 2003).

Cassava Production

Cassava Tuber

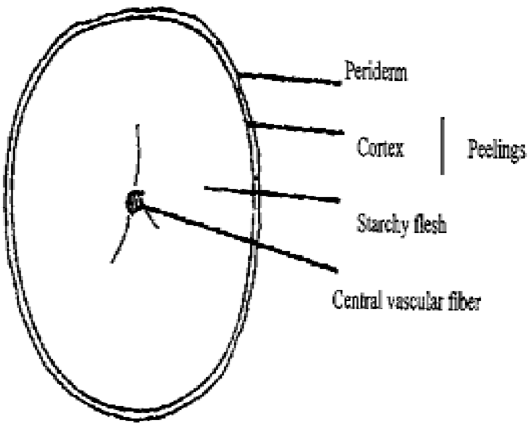
Cassava is a woody shrub, perennial plant that belongs to the spurge family (*Euphorbiaceae*). It is extensively cultivated as an annual crop in the tropical and subtropical regions for its edible starchy tuberous root.

TIJERAT
ISSN: 2707-5654

Cassava is a primary staple food in the developing world, providing a basic diet for over half a billion people. It is one of the most drought-tolerant crops, capable of growing in marginal soils. The mature tubers can be 5-10cm in diameter and 15-30cm long when harvested 9-12 months after planting.

The three layers of cassava tuber as described by (Abdulkadir, 2012) are the following:

i. **The periderm**: the tubers uttermost layer, the peel (rind).
ii. **The cortex**: usually about 1.5 to 2.5mm thick and white in colour. This lies below the periderm.
iii. **The central portion of the tuber**: mostly composed of stored starch, which is white in colour. This makes up the more significant bulk of the cassava tuber.



(1a) (1b)

Figure1a: The different layers of cassava.

Plate 1b: Cassava tubers. Source: Anonymous, 2021

According to a study by (Nweke, 2002), cassava is vegetatively propagated through stem cutting and produces well on poor soils. He added that the tubers may be kept in the soil for extended time periods. This features and high crop yield contribute to the importance of cassava in Africa, South East Asia and South America. Also, cassava can be grown on poor soil with little or no investment in irrigation, fertilizer or pesticides.

Schael, (1999), studied the history of the crop and stated that the beginning of interest in the crop in recent time results from the realization of the potential of cassava as a food security and emergence crop which could generate employment for the rural poor and foreign exchange for the country. Since 1990, the government, through the ministry of food and agriculture has demonstrated its determination and commitment to promote cassava for the alleviation of poverty particularly in rural households and communities. He maintained that the main reasons for expansion of cassava production are population growth, famine or seasonal hunger and market availability. In Nigeria, cassava is moving from starvation prevention crop to cash crop for local urban consumption. The top cassava producers are in order, Nigeria, Brazil, Thailand and Indonesia. The next six countries are all in Africa.

Cassava Production in the World

Nigeria is currently the largest producer of cassava in the world with an annual output of over 34 million tons of tuberous roots. Cassava production has been increasing for the past 20 or more years in area cultivated and in yield per hectare. On average, the harvested land area was over 80 percent higher during 1990–1993 than during 1974–1977.(Federal Ministry of Agricultrue and Natural resources, Department of Agriculture, 2021).

In 2018, global production of cassava root was 278 million tones with Nigeria as the world largest producer, having 21% of the world's total. Other major growers were Thailand and Democratic Republic of Congo (FAOSTAT, 2019). A summary of their major findings is presented in table 2.1 below.

Table 2.1: Cassava production 2018inselected countries

S/No	Country	Production (millions of tons)	Percentage (%)
i.	Nigeria	59.5	21.4
ii.	Thailand	31.7	11.4
iii.	Democratic Republic of Congo	30.0	10.8
iv.	Brazil	17.8	6.4

v.	Indonesia	16.1	5.8
	World's Total	**278**	**100**

Source: FAOSTAT of the United Nations.

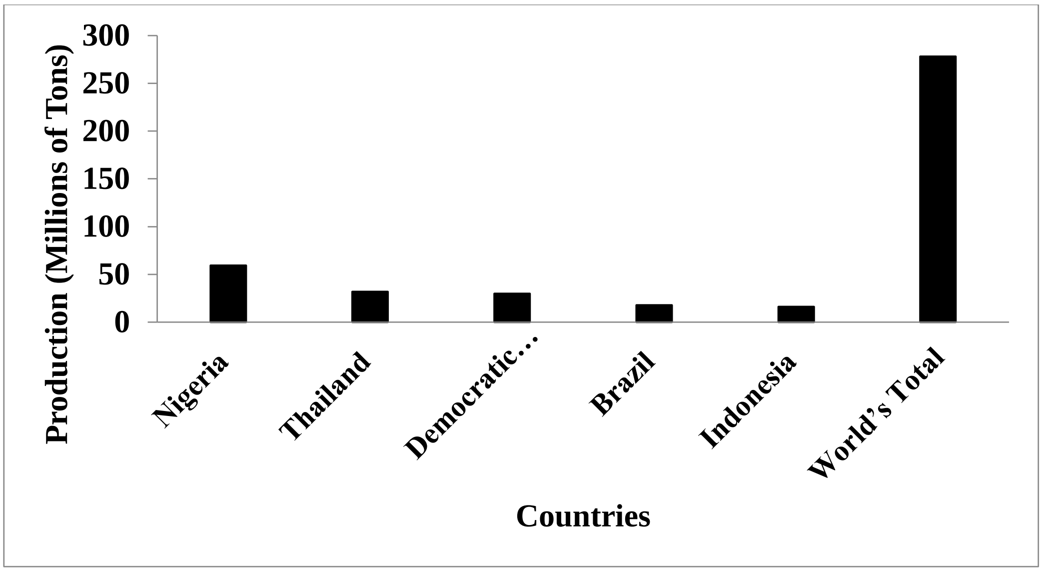


Figure 2: Cassava Production in 2018 in selected countries

FAO, (2013), reported a steady rise in the production of cassava across the world. From their study, it can be deduced that the production in Nigeria drops from 44 million tons in 2008 to 36 million tons in 2009, there was however an increase in the production in the following year as production rises to about 42 million tons in 2010. In 2011 and 2012, Nigeria's production output was put at about 52 million tons and 54 million tons respectively. This goes to show that Africa has the largest production output in the world as reported by FAO, (2013).

Cassava Production in Nigeria

Prior to the discovery of oil in the 1970s, agriculture was the mainstay of the Nigerian economy, accounting for about two-thirds of the Gross Domestic Product (GDP). With the oil boom, agriculture's contribution to GDP declined to 25 percent by 1980 and Nigeria moved from being a large exporter to a major importer of agricultural products. Since the mid-1980s, as a result of a decline in oil revenue and policy measures implemented under a Structural Adjustment Programme (SAP), agriculture's contribution to GDP has risen to about 40 percent.

In all, over four-fifths of the cultivable land area is suitable for cassava growing (Figure 3).

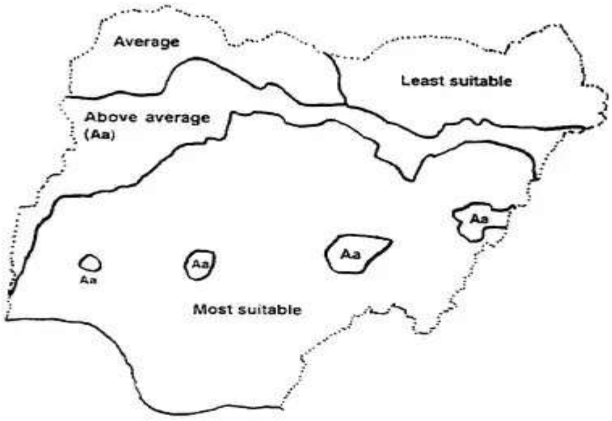


Figure 3. Agro-ecological suitability zones for the cultivation of cassava, based on combined data for soils, mean rainfall, mean temperature, temperature range and the length of growing season in Nigeria. Source: (FMANR, DA, 2021).

Varieties of Cassava Grown in Nigeria

In a study by FAO (2001), they stated that cassava is classified as either sweet or bitter, like other roots and tubers; both bitter and sweet varieties of cassava contain auto nutritional factors and toxins with the bitter varieties containing much larger amounts.The major cyanogenic glucosides found in cassava are linamarin and lotaustralin, which can be hydrolysed into hydrogen cyanide (HCN) (Iglesias *et al.*, 2002). Hydrogen cyanide is a toxic compound harmful to human health and could lead to death if consumed in excess (Nhassico *et al.*, 2008; Burns *et al.*, 2012). Bitter cultivars of cassava root have higher level of cyanide content (28 mg HCN/ kg) than the sweet type (8 mg HCN/ kg) dry weight basis (Chiwona Karltun *et al.*, 2004; Charles *et al.*, 2005). Sweet cassava root cultivars with lower cyanide content can be eaten fresh or boiled (Nhassico *et al.*, 2008), while the bitter type with higher cyanide concentration require further processing to eliminate the toxins before consumption (McKey *et al.*, 2010). They must be properly prepared

before consumption, as improper preparation of cassava can leave enough residual cyanide to cause acute cyanide intoxication, goiters, and even ataxia or partial paralysis. Cassava is the most favored among all tuber crops and even all food crops (Bamiro, 2007).
Some of the principal recommended cultivated varieties in Nigeria include; TME419, TMS90257, TMS 91934, TMS81/00110, TMS82/00661

Processing of Cassava

Cassava Processing

Machines for cassava processing are made to replace the hand-operated method (manual) and to increase output to attain the required demand for food, fiber, and materials. Suitable mechanization and automation are vitally needed to achieve the desired end product. Some manual methods like peeling, washing, grating, pounding, pulverizing and pressing are successfully mechanized with the help of development and modernization.

Cassava Graters

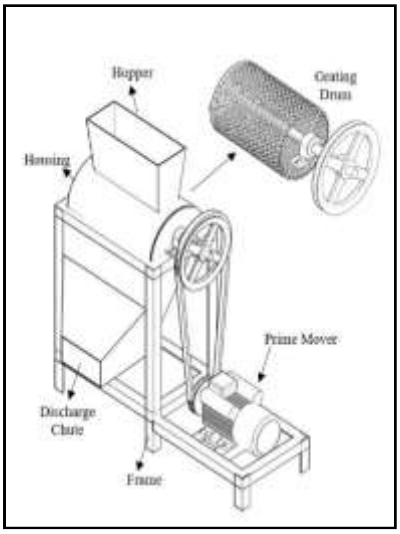
Grating of cassava means the transformation of cassava tubers into pulp form. Grating of cassava can be done by machine called cassava grating machine of various makes. The cassava grating machine is widely used in the garri and starch processing industries to grate raw materials into garri or starch slurry.

Manual grating

Adejumo, (1994) design and fabricated a wooden grater in which the cassava forced into a hopper is rubbed against the grater which is being electrically powered. Enhance quality of cassava can be grated using this method. However, the durability of the grater is low because of its wooden nature.
Ndaliman, (2006) described a pedal operated cassava grater which is powered by human efforts applied to pedal. The grater pulverizes the cassava tubers into paste which can pass through a wine sieve. The effective performance of the design was at 60%.

Mechanical (Motorized) grater

Darlene, *et. al.,* (2019), reported in their study "Design, Fabrication and Performance Evaluation of Motor-Operated Cassava Grater", that the motor-operated cassava grater was developed, fabricated and evaluated using locally available and low-cost materials for household-level processing. Peeled cassava tubers were grated at three various grating drum rotational speed determined by using three pulley diameters (5, 6 and 8 in) with an average speed of 1424.30rpm, 1148.30rpm, and 857.40rpm, respectively. The cassava grater was run by 1.5-hp electric motor and its performance was evaluated in terms of grating capacity, grating efficiency, percentage loss and fineness modulus (FM). They analyzed Eachparameter statistically using completely randomized design. The manual grating was also conducted in comparison to the fabricated machine. From the parameters tested, they found out that the 5-in diameter pulley with an average grating capacity of 283.26 kg/hr, grating efficiency of 91.56%, percentage loss of only 8.44% and FM of 3.38 came highly recommended.



(3)

(3)

Figure 4. Perspective CAD image of the cassava grater

Plate 3: Actual view of the motor-operated cassava grater

Source: Darlene, *et. al.,* (2019),

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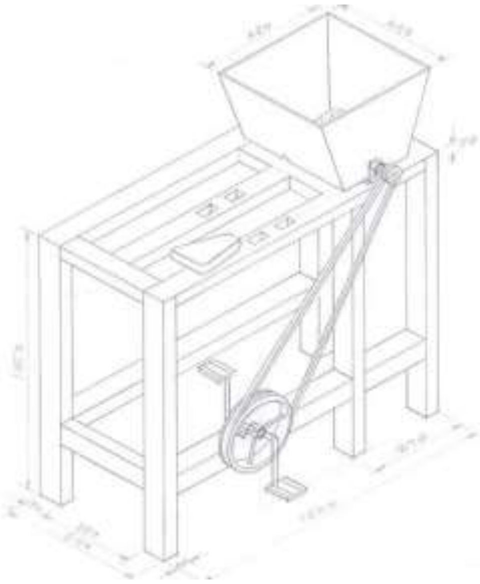
ISSN: 2707-5654

This implies that as the pulley size decreases, the grating time also decreases. This is because smaller pulleys have faster operating speed than larger ones. Moreover, the time for the manual grating is much slower compared to the machine because it depends on the person grating the cassava. The manual grating is a painful and tedious work, as stated by (Opandoh, 2014), manual grating would require 10 to 15 working days to grate a ton of peeled cassava.



(5) (4)

Figure 5. Isometric view of the cassava grater with dimension in mm
Plate 4. Picture cassava grater with grating chamber opened for visible grating roller
Source: (Yusuf, *et. al.,* 2019).

In a similar study by (Yusuf, *et. al.,* 2019), they researched that a simple manually operated cassava grater can be fabricated using hardwood, galvanized sheet, iron rod, bicycle pedal and bearing. They affirmed that the grater was effective for grating cassava tuber in rural areas where electricity, petrol and other social amenities were lacking. The test carried out shows that the grating efficiency of the cassava grater was 90.91% and the grating capacity was 102.9kg/h. They concluded by recommending that manually operated cassava grater be fabricated for rural women to remove drudgery and alleviate the problems associated with grating cassava tubers in the rural areas.

Plate 5. A Dual - Operational Cassava Grating Machine, Source: (Ndaliman , 2006)

Ndaliman, (2006), described the procedures of tests that were conducted using the machine. He reported that cassava tubers were obtained from a farm and peeled manually, thoroughly washed and weighed using weighing balance scale. The machine was operated for some minutes to allow speed to stabilize. Peeled cassava was introduced into it through the hopper. A piece of wood was used to press the cassava against the drum to prevent scattering of the cassava caused by machine vibration. The pulp was collected into a sac and taking to a press for dewatering. The dewatered pulp was weighed and recorded using the weighing balance scale. The pulp was then sieved. The weight of sieved and unsieved materials was recorded.
He also carried out a performance tests which indicated that high values of grating efficiencies are attainable when powered electrically and manually operated.

He reported that both tests were conducted using 2.0kg of cassava. When manually operated, the grating efficiency was found to be 92.4%. That of electrically operated machine gave the efficiency of 91.95%. These levels of performances according to himis satisfactory.

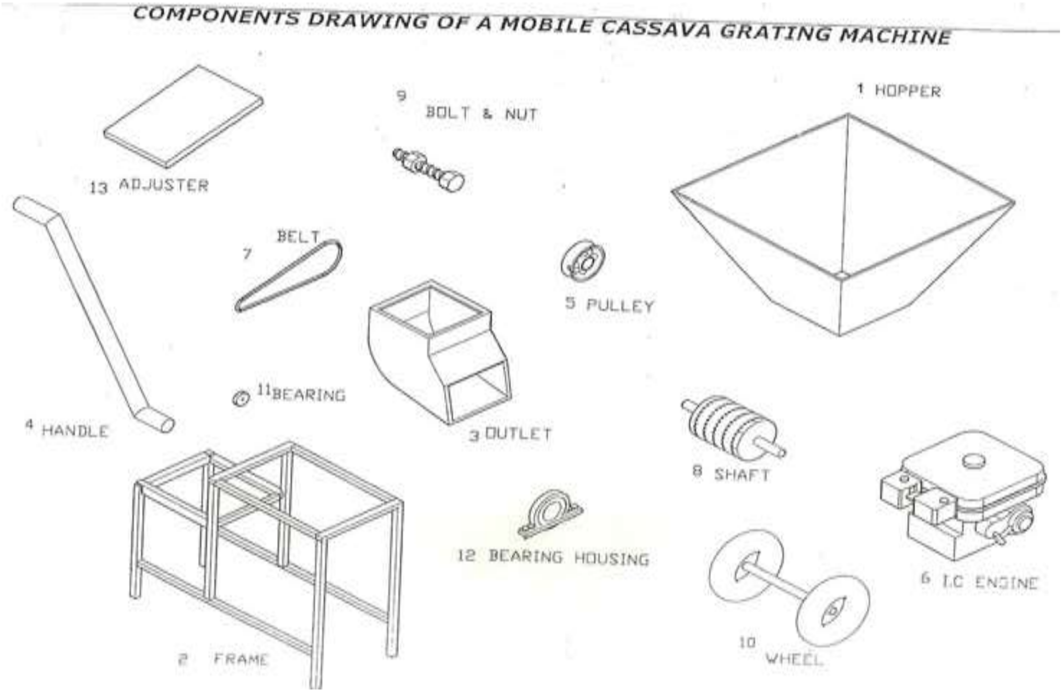


Figure 5. Components drawing of a mobile cassava grating machine. Source: (Aideloje, *et. al.,* 2018)

Aideloje, *et. al.,*(2018) contructed a cassava grater that consists of a hopper unit, the grating drum and the delivery channel; it also consists of tyres for easy mobility. All these components are assembled on a frame made from angle bars. The machine is mechanically powered; the grating drum is also made of metallic cylinder that carries a perforated plate which served as the grater. The machine cost ₦42,000.00 to produce, with an output capacity of 55.79 kg/hr.

Utilization of Cassava Products

Uses of Cassava

Cassava is a major staple crop in Nigeria as cassava and its product are found in the daily meals of Nigerians. It has five primary industrial products which stand out to be very important for Nigerians, they are native starch, garri, cassava flour, crude ethanol and animal feed (cassava chips pellets) (Onyenwoke and Simonya, 2014). It has many uses in addition to producing nutrition to humans.The leaves can be eaten as a vegetable or cooked as a soup. They can also be dried as hay and given as feed stuff to animals for extra protein. The tubers can be processed into many products as follows:

Fermented cassava products

Fermentation is one method of processing cassava into another food form which not only improve the flavour and taste of the product but extends the shelf-life (FaladeandAkingbala, 2010). Fermentation is one major method employed during processing, which enhances the reduction of the cyanide level and detoxification of the root (Kostinek, *et. al.*, 2005). Some notable products from fermented cassava include:
Flour: the flour can be used to produce most of our local food and even foreign food.

Plate 8: Cassava flour. Source: Anonymous, 2021

These products include among others the following:

Cassava bread

Cassava bread is a fermented product prepared from the combination of wheat flour and cassava flour in the ratio of 5:1 (Shittu, *et. al.*, 2008). This proportion has been observed to give acceptable fresh loaf. Cassava flour is processed into dry flour by drying at temperature of about 50°C to ensure that flour retains its creamy colour after drying. This process has the ability of improving the use of cassava flour as composite flour in baking industries.

Plate 10: Cassava bread. Source: Anonymous, 2021

Cassava fufu

Fufu is an acid-fermented cassava product that is processed through the submerged fermentation of peeled roots in water. Fufu is a common traditional food for the West African countries (OyewoleandSanni, 1995). The softened root is then pounded into wet fufu and the following processes are adopted: steeping the root in water for 2 – 3 days to soften the pulp and there after it is screened, allowed to sediment, dewatered with cloth bags, cooked and finally pounded into *fufu*. The quality of fufu is determined by the texture, aroma and colour (creamywhite or yellowish) depending on the variety used. The quality of fufu is greatly affected by season, the processors and also most especially the variety (Obadina *et al.*, 2009).

Plate 12: Cassava fufu (Akpu). Source: Anonymous, 2021

Fermented cassava starch

This is a modified starch from fermentation of cassava root. It can be used for frying and baking of cheese bread in some countries such as Brazil (Srinivas, 2007). The process involves steeping already peeled and grated cassava roots in a tank of water for a period of 20 to 70 days to allow fermentation. This steeping process in adequate water helps in separating the starch granules from the fibre and other soluble compound. After fermentation, the obtained starch is dried to produce a powdered product. Although, soaking process is essential, it could cause deterioration of starch and thus reduce its usefulness in the food and pharmaceutical industries (Taiwo, 2006).

Plate 11: Cassava starch. Source: Anonymous, 2021

Garri

Garri is the most commercial and useful product from cassava processing. It is creamy-white, pregelatinized granular and high calorie food with a slightly sour taste (FaladeandAkingbala, 2010). It is processed from fresh cassava roots following very tedious operation of peeling and grating into mash (Fadeyibi, 2012). The grated pulp is put in sacks (Jute or polypropylene) and the sacks are placed under heavy stones or pressed with a hydraulic lack between wooden platforms for 3 - 4 days to dewater the pulp and allow fermentation to take place (FaladeandAkingbala, 2010). This traditional way of processing cassava root into garri is monotonous, timeconsuming, requires more labour and hazardous to health because processors are usually exposed to smoke and heat during frying (Taiwo, 2006).

Garri is regarded as precooked convenient food which can be eaten as a snack and the long period of frying contributes greatly to its longer shelf-life (Fadeyibi, 2012).

Plate 13: Garri. Source: Anonymous, 2021

Chips: cassava chips can be used for animal feed.

Plate 9: Cassava chips. Source: Anonymous, 2021

Plate 14: Flow chart of Cassava ethanol processing. Source: Anonymous, 2021

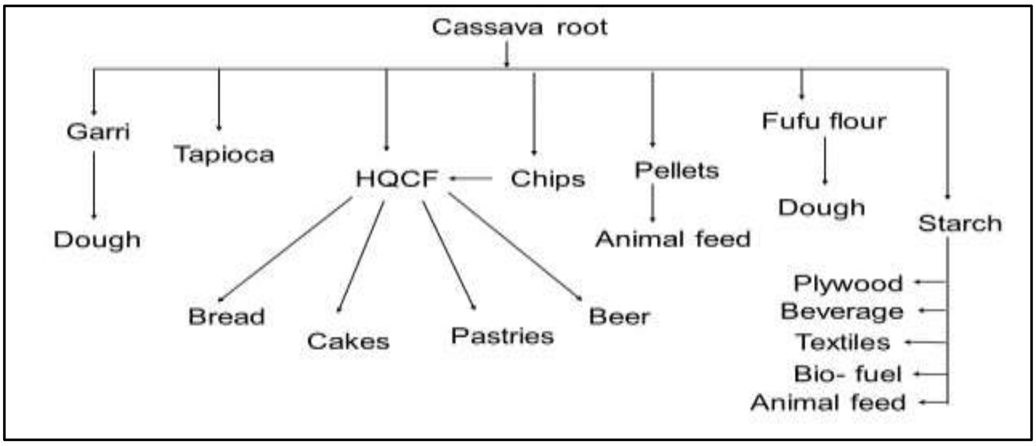


Figure 7: Different products derived from minimal processing of cassava root (Montagnac *et. al.*, 2009; FaladeandAkingbala, 2010).

Economic Importance of Cassava Productions

Compared to grains, cassava is more tolerant of low soil fertility and more resistant to drought, pests and diseases. Furthermore, its roots are storable in the ground for months after they mature. These attributes combined with other socioeconomic considerations are therefore what IFAD has recognized in the crop as lending itself to a commodity-based approach to poverty alleviation (FAO/IC, 1995) as reported in (FMANR, DA, 2021).Cassava performs five main roles:

i. Famine reserve
ii. Rural staple food
iii. Cash crop for urban consumption
iv. Industrial raw materials and
v. Foreign exchange

Challenges of Cassava Production in Nigeria

Constraints in cassava production include a wide range of technical, institutional and socioeconomic factors. These include pests and diseases, agronomic problems, land degradation, shortage of planting materials, food policy changes, access to markets, limited processing options and inefficient/ ineffective extension delivery systems.

Pests and diseases

Cassava is plagued by various diseases and insect pests. Pests and diseases including the mealybug (which has been greatly controlled), green spider mite (GSM) and the large grain borer which attacks dry chips of cassava in storage.

In the 1997 season, the various diseases and pest considered to be most important in seven cassavaproducing states were: mosaic disease, bacterial blight, leaf rollers, termites, anthracnose, root rot, mealybugs, spider mites, white flies, rodents and stem girdlers. In different areas of the cassava production zone, one or more pests and/or diseases are important.

White ants (termites) destroy stems that are planted before they sprout. Some areas appear to be very prone to this problem. A higher plant population (12–13 000 plants/ha) is used to compensate for those that would be lost. Various chemical control measures are recommended, but the need for safe use and high costs restricts their use among many small farmers who grow cassava in mixtures. Also, the menace of rodents is a regular occurrence in the field.

Agronomic problems

Biotic constraints

Use of low yielding varieties. The varieties in use by farmers often yield less than 10 tons/ha when there are new varieties that can give root yields of over 30–35 tons/ha. The local varieties are very susceptible to diseases and pests of cassava although consumers and processors still prefer them for specific uses and characteristics. Also, Livestock damage of cassava farms have been widely reported. Thus, the community arrangements to protect farms are made to include as many crops as possible.

Abiotic constraints

Low soil fertility affects many cassava-growing areas because the fallow periods are shorter as the pressure on arable land near homesteads is increasing. At the fresh tuberous root yield of 30 tons/ha (which is feasible under good field practice), the amount of major nutrients removed from the soil at harvest amounts to 164 kg of nitrogen, 31 kg of phosphorus, 200 kg of potassium, 80 kg of calcium and 31 kg of magnesium. Also needed are about 7 kg of a combination of several important microelements, e.g. iron (3.6 kg), manganese (1.4 kg), boron (0.5 kg) and copper (0.2kg) (Asher *et al.*, 1980). Meanwhile, as the direct use of soil amendments in cassava cultivation is low, the yield potentials of the various varieties of the planted cassava crop are not often attained. The use of organic manure could improve soil properties, but this technical fact seems not to be economically feasible under the circumstances of most cassava farmers.

Land degradation

The principal causes of land degradation include soil erosion, deforestation and oil spillage. Erosion is a general problem all over the country, especially in the southeastern zone. Desertification resulting from deforestation is peculiar to central, northeastern and northwestern zones, while oil spillage occurs essentially in the oil-producing zones. Each of these processes tends to reduce the productive potential of land and to impair the sustainability of soil fertility.

Shortage of planting materials

The cultivars released for cultivation in Nigeria have not all been extended to farmers. Although 17 have been released only about five of them have been made available to farmers. Out of these five, two varieties; TMS 30572 and 4(2)1425, continue to dominate. This seems to be related to the higher availability of the stems from distribution agencies of government and other partners. Many released varieties are yet to be multiplied on a large-scale and made available. Shortage of planting materials is also compounded by farmers' inability to preserve planting materials.

Food policy changes

The dramatic increases in prices of most tradable agricultural exports that accompanied the devaluation of the naira and the liberalization of exports were not applicable to cassava and cassava products to any significant extent because as a non-tradable staple food product, prices were not directly influenced by world market developments.

There is, thus, evidence of a lack of synergy between macroeconomic and sectorial policies; the macroeconomic policies have not been able to secure macroeconomic stability, an external balance or a diversified economic base. Consequently, there is a serious inconsistency giving conflicting signals to the farmers.

Poor access also makes movement of goods and people difficult. This is more so during the rainy season when many parts of the rural area are inaccessible. The roads linking the major towns are usually quite good. Though the farmer market access food network is better in Nigeria than in other countries studied by COSCA (Nweke *et al.,* 1992) the rural feeder road networks are poorly developed and absent in some places. This has significant implications for marketing, cost of inputs, access to health facilities and other social services and may therefore have adverse effects on production and rural standards of living.

Access to markets

Marketing can be a problem for poor farmers who may not have resources to transport their commodities to the market, especially those living in villages with poor feeder roads. Typically, farmers transport their farm produce to the market on heads as head loads, on bicycles or in lorries. With poor market access, marketing of cassava can be particularly problematic because of its bulky nature, especially if it is not processed.

Diversification of processing options

Compared with many countries of Africa, there is a wide range of cassava food products in Nigeria. However, industrial demand for cassava is relatively small, probably less than 5 percent of the total production. There is a potential market for cassava products in animal feed, flour and starch industries, but the size of the industrial, market is small because of an inadequate supply of cassava products, a weak link between industrial processors and producers of cassava products and a preference for imported starch.

Extension delivery system to farmers

There is the defectiveness in the use of contact farmers as recommended by Benor and Baxter (1986). In principle, contact farmers were expected to have multiplier effects on the adjacent farmers. However, there is insufficient formal feedback to the ADPs and limited spread of extension messages outside the contact farmers.

Furthermore, recent economic changes have caused input prices to rise more rapidly than product prices, reducing profit margins for small-scale processors of cassava products. To ensure that increases in yields bring some benefit to the women who are primary processors of cassava, alternate product markets need to be developed. Products that have a potential for improved market outlets include flour, starch and cassava chips for industry.

Another fundamental problem with extension strategy is the irrelevant nature of some of the recommendations. Quite often, the technological options offered by extension do not fit into the farming system and the socioeconomic conditions under which the rural people are operating. For instance, a broader range of new varieties that match different ecologies and end-user requirements should be developed and released to farmers.

Conclusion

Cassava is a major source of carbohydrates in human diet. It is widely cultivated and serves as a major source of income in countries like Nigeria, Brazil, India and most West African countries. The tubers of cassava cannot be stored longer after harvest before decaying. Due to this short storage period of the tubers, cassava tubers are further processed into other forms to enhance its storage and to serve other purposes including garri, fufu, chips, bread, *danwake*, just to mention a few.Hence the constructed grating machine has been found to be effective and efficient in the processing and extension of the shelf life of cassava.

Recommendation

Consequent on the findings of this study, the following recommendations are made

TIJERAT
ISSN: 2707-5654

i. Proper postharvest technology be researched that will help to store cassava tubers for a long period of time after harvest.
ii. Since the opportunities in world cassava market are high, it is essential that cutting edge scientific methods are invented to achieve optimization and precision in cassava production so that local farmers can directly and indirectly benefit from the growing global cassava market.
iii. Loan facilities should be provided for rural as well as commercial farmers of cassava so that they can expand the production of cassava and also purchase modern equipment's for harvesting, processing and storage of various cassava products.
iv. There should be deliberate efforts to raise awareness on improved yield performance through the agricultural extension services.
v. Intensive advocacy for research institutes to make improved cassava and disease resistant cassava varieties available and accessible to farmers.

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