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Cassava processing and its food application: A review

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Abstract
Cassava is the most important tropical tuberous crop widely used in in many countries Nigeria, Thailand and Indonesia are the top cassava producing countries. It is a versatile root vegetable that is widely consumed in several parts of the world. It contains many nutrients which found health benefit, high in calorie, and vitamin C that act as an antioxidant which support collagen production and enhance immunity. Its roots are the major source of starch and dietary energy, it is also known to be the highest producer of carbohydrates among stable crops. In current scenario, new food application of cassava as a flour in gluten-free or gluten reduced products (e.g., bread, biscuit, muffins etc). This review highlights the utilization and application of cassava as flour and starch in industrial scale.

Keywords: Cassava processing, food application, Nigeria

Introduction
Cassava is a starchy root vegetable and underground part of the cassava shrub, which has the Latin name *Manihot esculenta*, commonly called cassava, yuca, mandioca like potatoes and yams, it is a tuber crop. Though tuber is the main product of cassava plant, its young branch and leaf is also edible both for human and animal (Fakir *et al*., 2010) [24]. It is an important dietary staple in many countries with in the tropical regions of the worlds (Perez and Villamayor, 1984) [51] where it provides food for more than 800 million people (FAO, 2007). Cassava root can be consumed raw as a snack or just after boiling like sweet potato (Fakir *et al.*, 2012) [23]. As a subsistence crop, it is the third most important carbohydrate food source in the tropics after rice and maize, providing more than 60% of the daily calorific needs of the populations in tropical Africa and Central America (Nartey, 1978) [42]. Cassava is the second most important staple food crop in sub-Saharan Africa, providing an average of 285 cal day^{-1} per person (FAO, 2000). It is the chief source of dietary food energy for the majority of people living in the lowland tropics, and much of the subhumid tropics of West and Central Africa (Oladunmoye *et al.*, 2014) [48]. The most important feature of cassava is its adaptability to a wide variety of ecological and agronomic conditions (Benesi *et al*., 2004) and has the ability to grow on poor soils where other crops do not grow well. Its roots can be stored in the soil for up to 24 months, and some varieties for up to 36 months, harvest may be delayed until market, processing, or other conditions are favorable (Nartey, 1978) [42]. It has drought-resistant root which offers it a low-cost vegetative propagation with flexibility in harvesting time and seasons (Haggblade *et al*., 2012) [33].

Cassava roots are a rich source of carbohydrate, most of the carbohydrate is present as starch (31% of fresh weight) with smaller amounts of free sugars (less than 1% of fresh weight). Cassava roots are low in protein (0.53%), although higher concentrations of 1.5% have been reported by (Ekpenyong 1984) [21], and fat (0.17%). The roots are the main portion of the plant to be used with a typical composition range of: moisture 62 to 66%, starch 28 to 33%, sugars 0.4 to 1.2%, protein 0.4 to 1.5%, dietary fibre 1.4 to 1.6%, fat 0.1 to 0.3% and ash 0.5 to 1% (Bradbury and Holloway, 1988) [10]. Iron and vitamin A are considered to be low. Proximate composition of cassava root is shown in Table 1.

In the regions where cassava is cultivated, the flesh color is traditionally white (Vimala *et al*., 2010) [65]. This is conventionally important to produce “white” starch or high-quality flour. White-flesh (and other dull colored) variants have negligible carotenoid content compared to yellow-flesh variants (Bradbury *et al*., 1988; Dowell and Oduro 1983; Montagnac *et al*., 2009 and Gegios *et al*., 2010) [10, 16, 41, 30]. cassava roots have a low protein content of about 1–3% on dry basis, and are particularly poor in sulfur-rich amino acids. Acidic and basic amino acids such as glutamic, aspartic and arginine are, however, relatively plentiful in cassava roots (Gil *et al*., 2002) [32].

The fiber content of cassava roots depends on the variant and age at harvest (Montagnac *et al*., 2009) [41]. A relatively higher fiber content of 0.62–4.92% has been found in roots of white-flesh cassava variants than in yellow-flesh and cream-flesh variants (Ukenye *et al*., 2013) [64]. Cassava is generally considered to have a high content of dietary fibre, magnesium, sodium, riboflavin, thiamin, nicotinic acid and citrate (Bradbury and Holloway, 1988) [10]. Average content of zinc, iron, calcium, magnesium, sodium, potassium and sulfur (dry basis) were 6.4 mg/kg, 9.6 mg/kg, 590 mg/kg, 1153 mg/kg, 66.4 mg/kg, 8903 mg/kg, and 273 mg/kg, respectively. Other minerals were only found in negligible quantities. Total phosphorus content in cassava is as low as 70–120 mg/kg of root (Rickard *et al*., 1991) [54]. Other micronutrients of more recent significance and interest in cassava are pro-vitamin A carotenoids and vitamin C. Vitamin C, which is important for mineral absorption in the gut, is found in relatively higher amounts than carotenoids in fresh cassava (Ayetigbo *et al*., 2018) [6]. However, the unprocessed cassava root contains cyanogenic glycosides, especially in the fresh and tender parts and cortex. If cassava tissue becomes damaged during harvesting or storage, endogenous enzymes hydrolyze the cyanogenic glycosides and release toxic hydrocyanic acid, which limits the edible value of cassava (Ahaotu *et al*., 2017) [2]. The traditional method of cassava preparation is to remove the skin, chop into pieces, and then remove the cyanogenic glycosides by water immersion or other methods. The pieces are then sun-dried, ground and cooked, and sometimes combined with other cereals (Haiqin *et al*., 2019) [34]. In urban areas, cassava consumption of poor households is double that of non-poor households. In rural areas, poor households' consumption of cassava is triple that of non-poor households. When dried, cassava is both conservable and transportable over long distances (Akinpelu *et al*., 2011) [3]. Both the leaves and the tubers of a cassava plant can be used in a wide range of foods. The tubers are similar to potatoes and can be prepared in much the same way: boiled, fried or mashed. Cassava is a highly resilient crop that can withstand stress from drought and dry poor soils while still giving acceptable yields. In addition, cassava is easy to cultivate and its roots can stay reserved in the soil for several months (Bradbury and Holloway 1988) [10] when the farmer's storage space is limited, thereby creating opportunity for extended harvest and sustained availability.

Table 1: Proximate composition of cassava root (Uchechukwu-Agua *et al*., 2015) [63]

S. No.	Composition	Fresh Cassava Root
1.	Water (g/100g)	60.0
2.	Energy (kJ)	670.0
3.	Protein (g/100)	1.4
4.	Fat (g/100g)	0.28
5.	Carbohydrate (g/100)	38.0
6.	Fibre (g/100g)	1.8
7.	Sugar (g/100g)	1.7
8.	Calcium (mg/100g)	16.0
9.	Magnesium (mg/100)	21.0
10.	Phosphorous (mg/100g)	27.0

Types of Cassava roots

Cassava (Manihot esculenta Crantz) can be classified into two distinct classes - "sweet" or "bitter". Both bitter and sweet varieties of cassava contain antinutritional factors and toxins, with the bitter varieties containing much larger amounts. This is not because it is higher in sugars than other varieties, but because it is less poisonous. It may be classified into sweet and bitter based on the level of cyanogenic glucoside in the tissue (Uchechukwu-Agua *et al*., 2015) [63]. Cassava contains large quantities of cyanide compounds, which must be processed out of the tubers before they can be safely eaten. The sweet variety of cassava has fewer of these compounds, and does not require as much processing. Sweet varieties also produce higher yields, has lower total carotenoid contents (2.08-4.38 µg g^{-1}) (Araujo *et al*., 2019) [7]. sweet varieties can be eaten raw, boiled, or cooked without prior processing, bitter varieties are needed to processed to reduce risk of residual cyanogen prior to consumption (Chiwona-Karltun *et al*., 2000; Dufour 1988) [14, 60]. Bitter cassava is very similar in cultivation and general appearance to sweet cassava, but produces much higher quantities of cyanide compounds. It can be visually very similar to the sweet but require careful processing to make the flour safe to eat. 'Bitter' cassava had higher starch and sugar contents than the group of 'sweet' cassava (Araujo *et al*., 2019) [7]. The presence of cyanide in cassava constitutes a clear threat to health, unless these compounds are removed before the cassava is consumed. Unprocessed cassava is toxic enough to cause death, but insufficiently processed cassava will also cause mortality over a period of time, especially when quality protein is absent from the local diet. There are several methods of removing the cyanide from cassava. Simple drying reduces the level of cyanide, though this may not be adequate to make it safe for consumption. Soaking the roots in water first, to leach out cyanide, produces a safer starch. So does fermenting the roots, either whole, shredded or in pieces, before drying. Roasting the tubers, or boiling them in multiple changes of water, will also reduce the cyanide content.

Production and utilization of cassava

Tuber crop are cultivated in India mainly in the southern, eastern and north-eastern states. Cassava is grown in India in an area of 0.23 million hectares with a total production of 6.5 million tonnes (Edision, 2007). In the same period, Nigeria alone produced about 42.5 million metric tons which is estimated to be about 18% of total global production. Nigeria's share of world production had risen to 21.5% of world production by 2018. FAO projects that by the year 2025; about 62% of global cassava production will be from sub-Saharan Africa (FAOSTAT, 2020) [20]. The minimum production of cassava in the study area is 20,350 kg/ha (ODANRDO), 2018. It is cultivated in India in about thirteen states (out of 32 states and union territories) with major production in the South Indian states of Kerala (142,000ha) and Tamil Nadu (65,700 ha) (Edision, 2007). The worldwide production of cassava amounted to 278 million metric tons in 2018, out of which Africa's share was about 61% shown in Fig. 1. The Projected production and utilization of cassava in Indian and abroad in 2020 in Table 2.

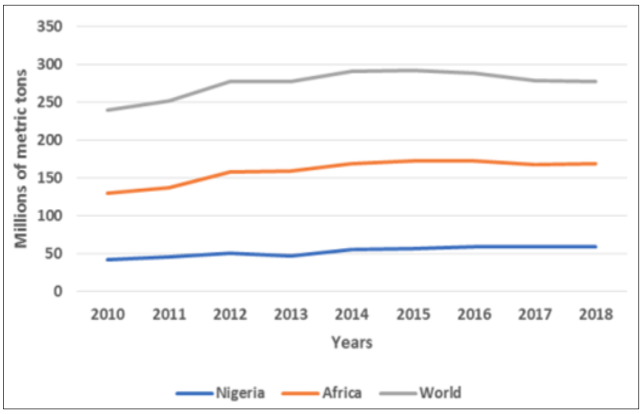

Fig 1: Production of cassava between 2010 and 2018 (FAO, 2020)

Table 2: Projected production and utilization of cassava in Indian and abroad in 2020

	Growth rate for utilization 1993-2020 (percent per year)			Utilization in 2020 (million tonnes)	Production in 2020 (million tonnes)
	Food	Feed	Total		
Southeast Asia	1.4	0.13	1.25	27.0	51.1
China	-1.27	2.08	1.19	3.9	4.2
Other East Asia	-0.95	1.09	0.63	3.5	0.0
India	1.00	0.00	1.00	7.6	7.8
Other South Asia	1.00	0.00	0.83	0.6	0.6
Latin America	0.26	1.26	0.78	39.3	40.5
Sub-Saharan Africa	2.51	0.29	2.47	166.0	166.0
Developing	2.01	1.18	1.88	248.8	271.1
Developed	0.03	0.01	0.02	22.7	0.4
World	2.01	0.59	1.68	271.6	271.6

***Source:** Adapted from Rosegrant and Gerpacio, 1997; and Scott et al., 2000b.*

Globally, cassava production has increased by 240 million metric tons since. According to FAO projections, by 2025, about 62% of global cassava production will come from sub-Saharan Africa (FAOSTAT, 2020) [20]. Cassava is a tropical crop and its center of origin is believed to be the Amazon region. It was already cultivated by South American indigenous populations (Demiate and Kotovicz, 2009) [17]. It has been reported that the crop originated from South America where it has been grown by the indigenous Indian population and was domesticated between 5000- and 7000-years B.C. (Olsen and Schaal, 2001; Akinpelu *et al.*, 2011) [47, 3] However, it is now grown throughout the tropical world (Fernandez and Alejandro, 1996) [22]. Its production is mainly from states of Kerela, Tamil Nadu and Andhra Pradesh. Cassava was brought into cultivation by the American Indians probably 4,000 years ago was later introduced to West Africa in the sixteenth century and then spread to other tropical regions of the world. It is very flexible with respect to planting dates and hence under irrigated conditions in the tropics, planting can be taken at any time of the year (Edision, 2007). Time of the planting of cassava for the different states in India is given in Table 3.

Table 3: Optimum time of planting cassava in four states of India

States	Rainfed	Irrigated
Kerala	April-May / Sep-Oct	Dec-Jan
Andhra Pradesh	June	March
Madhya Pradesh	June	March
Tamil Nadu	June	Sep (higher yield)

The first import of cassava to Africa was by the Portuguese from Brazil in the eighteenth century, but now cassava is cultivated and consumed in many countries across Africa, Asia and South America (Nhassico *et al.*, 2008; FAO 2013) [43, 29]. Nigeria, Thailand, Indonesia, and Brazil are the largest world producers of cassava. There are several varieties grown in the world but Brazil keeps the vast genetic diversity (Olsen *et al.*, 1999) [46]. Nigeria has been ranked as the world's largest producer of cassava since 2005 and in 2010 the production of cassava was estimated to reach 37.5 million tonnes (FAOSTAT, 2012) [28]. Presently more than 60% of cassava produced is used for industrial purposes, 30% is used for animal feed and only 10% is used for human food Cassava production in Cambodia in each year varied according to market condition. The harvested area, yield and production were higher in years of favorable market condition in 1980, 1981, 1988, 1992 and 1999. The harvested area, yield and production in 1999 were 14,000 ha, 16.3 t/ha and 228,512 tonnes fresh cassava roots (Bien *et al.*, 2007) [53]. In India, as far as utilization pattern is concerned, cassava is used as a secondary staple in Kerala, while it is used as raw material for the production of starch and sago in Tamil Nadu and Andhra Pradesh.

Annually 300,000 tonnes of sago and starch are being produced of which Tamil Nadu's share is more than 80%. Chips is another []value-added product; nearly 70,000 tonnes are produced from cassava, more than 50% of it from Andhra Pradesh. Total amount of products exported annually ranges from 30,000 to 50,000 tonnes (Edision, 2007). More than 291 million tons of cassava were produced worldwide in 2017, of which Africa accounted for over 60%. In 2017, Nigeria produced 59 million tons making it the world's largest producer (approximately 20% of global production) with a 37% increase in the last decade. Cassava production depends on a supply of quality stem cuttings. The multiplication rate of planting materials is very low compared to grain crops, which are propagated by true seeds. In addition, cassava stem cuttings are bulky and highly perishable as they dry up within a few days.

Cassava Starch and its processing

Processes involved in tapioca starch production and mass balance (Source: Chavalparit and Ongwandee, 2009 with modifications) is shown in Fig.2. The cassava roots (sweet and Irish) were washed to remove soils and dirt from their skin and peeled using kitchen knife. The peeled roots and tubers were washed, chopped into smaller pieces, milled with an electric grater and sieved by washing off in a basin of water. The mixture was filtered through a fine mesh sieve (muslin cloth) and the filtrate allowed to settle. The supernatant (effluent) was decanted and sediment obtained.

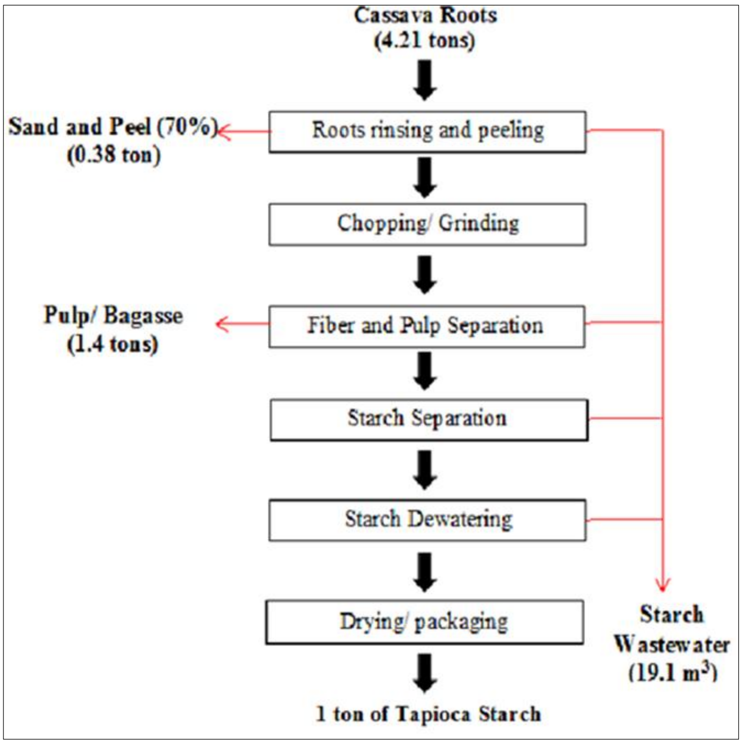

Fig 2: Process of starch production

Starch: Starch is the main plant carbohydrate is the most important plant derivative used by man. It is one of the most abundant substances in nature and a polymer of alpha glucose. It is a carbohydrate consisting of a large number of glucose unit and the major reserve polysaccharide of higher plants (Brown and Poon, 2005) [15]. Starch is heterogeneous in relation to both polymer structure and polymer molecular weight. Pure starch is a white, tasteless and odorless powder that is insoluble in cold water or alcohol (Ejiofor, 2015) [20]. It is present in large amounts which have 25% of starch content that is obtained from mature and good quality of cassava. Tapioca is a starch extracted from the storage roots of the cassava plant. It is approximately 21.5% of fresh cassava tuber (IITA, 1990) [38]. One of the major sources of starch is cassava which produces high purity and quality starch compared to other tuber and cereal crop sources (Nuwamanya *et al*., 2010) [44]. It is the most abundant carbohydrate component of cassava and is widely used as a replacement for corn starch in the United States (Charles *et al*., 2005) [15]. Cassava starches have been identified as round, spherical or round to angular (Fernandez and Alejandro, (1996) [22]. It is used in the production of glucose and high fructose syrup, in the sizing of paper and textiles, and in the manufacture of adhesives and alcohol (Tonukari, 2004; Rickard *et al*., 1991[54]; Chadha, 1961) [62, 54, 13]. Starch for human consumption, is very fine white powder obtained from peeled roots that have been rasped, washed, sedimented, and dried on paper under hygienic conditions. It is used in bread, milk products, bakery products, and sausages (Eguez, 1996). The functional properties of this starch include, for example, low gelatinization temperature, non-cereal flavor, high viscosity, high water binding capacity, bland taste, translucent paste and a relatively good stability (Glicksman, 1969) [27], and physical properties including rheological and viscoelastic characteristics are dependent on two distinct structural polysaccharide fractions- amylose (17-24%) and amylopectin (76- 83%) (Charles *et al*., 2005) [15]. The composition of cassava starch is shown in Table 3.

Table 3: Composition of cassava starch (Sriroth *et al*., 2000) [60]

S. No.	Parameter	Starch
1.	Moisture (max)	13%
2.	Fibre (max)	0.2
3.	Ash (max)	0.15
5.	Total acidity	1%
7.	Protein	0.3
8.	pH	4.5-7
9.	Fat	6%
10.	Carbohydrate	7%

Amylose/Amylopectin: Starch mainly consists of two polymers of D-glucose (Fig. 3). Amylose and amylopectin are glucans that differ in their structure and molecular weight. Amylose is a polymer of low molecular weight (1.03–4.89 x 10^5) while Amylopectin has a higher molecular weight (7.08–9.88 x 10^7) and its cluster-like structure (Cornejo-Ramirez *et al*., 2018). The structure of the starch granules depends on the way in which amylose and amylopectin are associated by intermolecular hydrogen bonds (Fernandez and Alejandro, (1996) [22].

Amylose is an essentially linear polymer of (1→4)-linked α-D-glucopyranosyl residues, while amylopectin is a very large, highly branched molecule consisting of much shorter chains of (1→4)-D-glucose residues connected by (1→6) α D-glycosidic linkages (Hizukuri, 1986) [36]. Amylose is made up of either a single or multiple long chains, and is therefore considered as linear or a slightly branched molecule (Takeda *et al*., 1992) [61] while Amylopectin consists of a large number of shorter chains connected together, which results in branching (Manners, 1989) [40]; and size is much larger than amylose (Bertoft, 2017). Amylose constitute 20-25% of starch content because of the OH group attached to the first carbon of a glucose molecule is removed along with an H atom attached to the fourth carbon of another glucose molecule in the formation of amylose (https://pediaa.com). Starch contains about 80% of amylopectin. Here, the glucose molecules are bonded to each other through the fourth carbon atom as well as the sixth carbon atom. The branches of amylopectin constitute about 5% of the molecule, link each 20–25 glucose linear units form very complex structure (Smith and Martin, 1993; Imberty *et al.*, 1991) [59, 39]. Amylose is soluble in water and can be hydrolyzed into glucose units by the enzymes α-amylase. Amylose in starch is responsible for giving the deep blue color in the presence of iodine. While amylopectin is a water-insoluble fraction but soluble in hot water with swelling. It can form starch gel or paste when it cools down (https://byjus.com).

The amylopectin molecules are larger when compared with amylose. Amylopectin has two important properties which are mostly quite popular for industrial purposes such as proper binding and starch retrogradation. These properties help in the usage of Amylopectin in the manufacturing of adhesives and Lubricants. The main purpose of Amylopectin is to act as an energy supplement for plants.

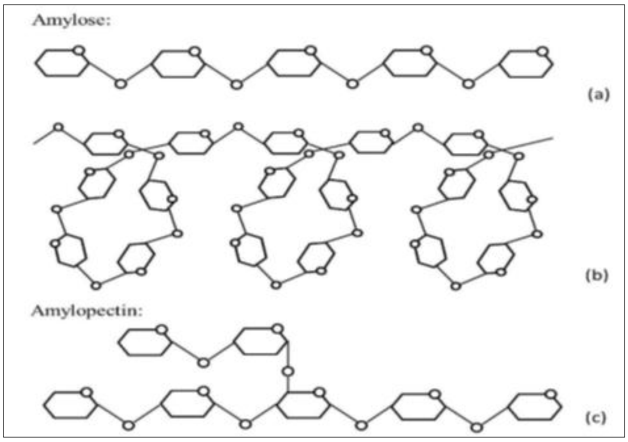

Fig 3: Structure of amylose ((a) linear (b) helical (c) amylopectin (Horstmann *et al*., 2017) [37]

Cassava Flour and its processing

Cassava flour are either prepared from milled dried chips or wet mash. Mashing of cassava root can be achieved by grating, pounding or milling of peeled roots. The prepared mash may either be fermented or unfermented. When the unfermented mash is dried and milled, it gives rise to a bland, odorless, white or off-white particulate product also known as high-quality cassava flour (HQCF). The flours from fermented cassava root are also known as lafun, fufu or pupuru in Nigeria has been reported by Shittu *et al*., 2018. The processing of cassava flour and composition are shown in Fig. 4 and in Table 4. Cassava flour contains carbohydrates, which are the main energy source for the body. It can replace grain-based flour or a gluten-free flour mix. Cassava flour comes in many forms, it is low in calories, fat, and sugar as compared with other gluten-free flours, such as coconut or almond, cassava flour has low-fat content. (www.webmd.com). It is a good substitute for wheat flour in bakery and other products. Cassava flour (CF) refers to the dry, fibrous and free-flowing particulate product obtained from cassava roots (Shittu *et al*., 2016) [58]. It is made by slicing or chopping peeled roots, either it is prepared from milled chips or wet mash then drying and milling them (Fernandez and Alejandro, (1996) [22]. The prepared mash either be fermented or unfermented. When the unfermented mash is dried and milled, it gives rise to a blend, odorless, white or off- white particulate product also known as high quality cassava flour (HQCF) (Shittu *et al*., 2016) [58].

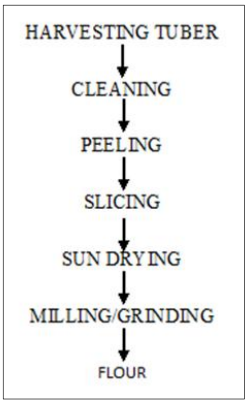

Fig 4: Process of the production of cassava flour (Fakir *et al.*, 2012) [23]

Flour extraction from cassava tuber depends on reduction of moisture (Fakir *et al.*, 2012) [23]. it is a valuable product obtained from cassava roots after processing, it is relatively cheap to produce traditionally. (Ayetigbo *et al*., 2018) [49]. The main advantage of this flour Cassava flour that it is a grain-free and nut-free flour and is naturally gluten free and a great flour to use in baking and cooking therefore people who avoid gluten can use it as a replacement for wheat flour in term of taste and texture. Cassava flour does absorb more liquid than wheat flour.

Table 4: Composition of cassava flour (CAC, 1989; ARS (2012); Agua *et al*., 2015)

S. No.	Parameter	Flour
1.	Moisture (max)	13%
2.	Fibre (max)	2%
3.	Ash (max)	3%
4.	Total acidity	1%
5.	Protein	4.4%
6.	pH	9%
7.	Carbohydrate	9.9%
8.	Fat	3.6%

Food Application

For industrial use, starch is classified as native or modified. Tapioca flour/starch is an excellent binding and thickening agent for multiple purposes- baking goods, cooking soups, or making bubble tea. If it is not possible to get tapioca flour from accessible stores, one can substitute the flour with different ingredients such as cassava flour, cornstarch, potato starch, etc. The FAO study suggests that global demand for cassava starch could increase at an annual rate of 3.1 percent, while regional growth rates are expected to be for Asia 4.2 percent, Latin America 3.4 percent and Africa 2.3 percent. Cassava flour is a grain free and gluten free baking flour that is great for cooking and baking (www.today.com). The technology for modifying starches with physical, chemical and biological processes is highly advanced and evolving rapidly. These modified starches are absorbing an increasing market share. At the same time, there is pressure in some industries, especially foods, to move away from modification based on chemicals (Hershey and Howeler, 2018) [35]. It is used directly in different ways or as a raw material for further processing, and its unique properties also suggest its use for speciality markets such as baby foods and non-allergenic products (Benesi *et al*., 2004). Different products derived from cassava root (Fig. 5)

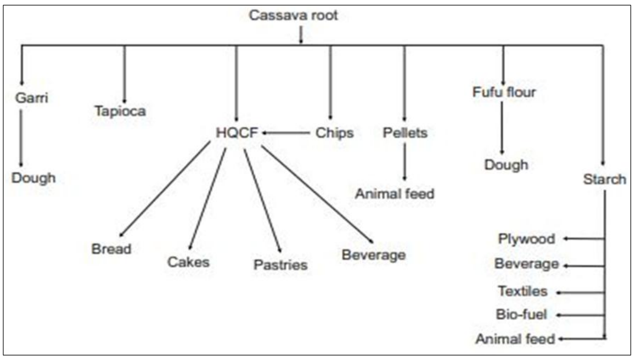

Fig 5: Different products derived from cassava root (Montagnac *et al*., 2009; Falade and Akingbala, 2010) [41]

Cassava starch is a valued raw material for producing many kinds of modified starches for food applications, one of the advantages is when compared to corn starch that represent over 75% of the world's starch market – is the absence of the undesired "cereal flavor" it is a key ingredient for food industry (Demiate and Kotovicz, 2011) [17]. Also used in large quantities in the manufacture of paper, plywood, textiles, and as a filler/stabilizer in processed foods (Hershey and Howeler, 2018) [35]. The structure of the starch granules depends on the way in which amylose and amylopectin are associated by intermolecular hydrogen bonds (Fernandez and Alejandro, (1996) [22]. Tuber of cassava is also used as raw materials in the garment, bakery, food and pharmaceutical industries (Bokanga *et al*., 1994; IITA, 2011; Fakir *et al*., 2012) [9, 38, 23]. Starch contributes greatly to the textural properties of many foods and is widely used in food and industrial applications as a thickener, colloidal stabilizer, gelling agent, bulking agent, water retention agent and adhesive (Goel *et al*., 1999) [31]. Cassava starch Is non-gluten, non-GMO (genetically modified organisms) and non-allergenic ingredient. Cassava starch is gluten-free which is highly preferred by consumers that are glutenin tolerant. It is mainly used in the manufacturing of monosodium glutamate (MSG) in various Latin American countries. Cassava starch is mostly preferred in various bakery products and confectioneries than any other starches. Starches are widely used as ingredients in many foods to impart textural and overall acceptability (Horstmann *et al*., 2017) [37]. The starch produced by cassava is amenable for use in various applications both dietary and industrial. Cassava roots normally begin to deteriorate within a few days after harvest. The processing industry has had to develop elaborate systems for coordinating supply of raw material with processing capacity. This has often worked best when roots are converted at the farm or village level to a more stable product, such as dried chips (Hershey and Howeler, 2018) [35]. Sago or tapioca starch is known to have high leaching and swelling abilities when cooked. This ability allows the application of both starches in expanded snack product made of starch-protein mixture (Adzahan *et al*., 2009) [1]. Cassava starches a key ingredient for food industry and also for other kinds of applications is its particular physicochemical behavior when cooked in aqueous dispersion, producing high clarity and high viscosity pastes (Che *et al*., 2007), as well as presenting a low gelatinization temperature and low tendency to retrogradation when compared to cereal starches (Demiate and Kotovicz, 2009) [17]. Cassava starch is a highly suitable material for food and industrial use. It is edible, non-toxic, and functionally important in the food and non-food sectors of industry (Ayetigbo *et al*., 2018) [49]. As an additive for food processing, food starches are typically used as thickeners and stabilizers in foods such as puddings, custards, soups, sauces, gravies, pie fillings, and salad dressings, and to make noodles and pastas (Ejiofor, 2015) [20]. Starches are widely used as ingredients in many foods to impart textural and overall acceptability. They are used as gelling, thickening, adhesion, moisture-retention, stabilizing, film forming, texturizing and anti-staling ingredients. In gluten-free products, starch is incorporated into the food formulation to improve one or more of these properties (Horstmann *et al*., 2017) [37]. In pharmaceutical industry, starch and its derivatives are employed as multipurpose excipients in various solid dosage forms, especially as disintegrants, fillers, and lubricants in powder form and as binders in paste form in tablet formulation (Riley *et al*., 2008; Adedokun *et al*., 2010; Builders *et al*., 2010; Riley and Adebayo, 2010) [55, 11, 56].

Cassava flour is used for making bread and other products like Chips, jam, jelly and chutneys (Fakir *et al*., 2012) [23]. Cassava flour, however, does not contain gluten and causes no allergic effects when consumed by the patients with celiac disease (Haiqin *et al*., 2019) [34]. One of the most popular uses of cassava flour is to replace wheat flour for bakery applications (Shittu *et al*., 2008) [57]. Cassava's competitive position in national and international markets is closely linked to internal and world supplies and market prices of alternative commodities or products. Because of cassava's versatility, it may compete with a range of products in different markets. In the market for balanced feed rations, cassava in dried chip or pellet form competes mainly with sorghum or maize, and sometimes barley. On a global level, maize is the principal source of starch (Hershey and Howeler, 2018) [35].

Conclusion

The cassava rich in carbohydrates and having some nutrients which is beneficial to human health. Some people who have suffering disease from gluten products so by the use of cassava root as in the form of flour and starch we should rid out from this problem. Recent days, in food industry there are some products like cookies, biscuit, cake, muffins, chips and paratha/tortilla are used to make in industry. Therefore, cassava flour replaces the wheat flour, rice flour, corn starch etc.

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