Effect of sprouting on cookability of cocoyam tubers and physicochemical properties of cocoyam flour

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ABSTRACT
The effect of sprouting on the cookability of cocoyam tubers was investigated. Cultivars of Xanthosoma sagittifolium and Colocasia esculenta were planted. The planted tubers were unearthed every two days; one portion was used to determine the cooking time of the samples while the other portion was peeled, washed, dried and ground into cocoyam flour. Some physicochemical properties (water, oil absorption and gelation temperature) of the cocoyam flour samples were determined. The cooking time for all the cultivars increased with increase in days of sprouting. At full sprouting time, the average cooking time for the tania varieties increased by 76.5% while that of taro varieties increased by 71%. It was also observed that all the cocoyam cultivars could no longer cook after full sprouting was observed which occurred within 8-12 days from the day of planting. Physicochemical properties of the cocoyam flour samples showed that the gelation temperature increased while water and oil absorption decreased with increase in days of sprouting.

Keywords: cocoyam, sprouting, cookability

INTRODUCTION
Cocoyam (Xanthosoma sagittifolium and Colocasia esculenta) is a tropical root crop which belongs to the Araceae family. It is grown in Nigeria and in many other parts of the tropics and sub-tropics of Africa (Sefa-Dedah & Agyir-Sackey, 2004; Iwuoha & Kalu, 1993; Purseglove, 1992; Irvine, 1969; Vickery & Vickery, 1979). Cocoyam corms and cormels are usually eaten boiled, roasted, pounded and sometimes mixed with other staples such as yam, cassava or plantain. It is widely used as soup thickener, which when added to soup fluid, absorbs the fluid and the soup thickens. Cocoyam is usually pounded to a soft dough known as "utara ede", which is eaten with different soup preparations in South eastern Nigeria (Ihekoronye & Ngoddy, 1985; Onwueme, 1978; Obiechina & Ajala, 1987). The estimated world production of cocoyam was placed at 5.5 million tons annually (FAO, 1991) with Ghana and Nigeria being considered as the world’s leading producers (Sefa-Dedah & Agyir-Sackey, 2004; Onwueme, 1982).

Cocoyam is nutritionally superior to other roots and tubers in terms of digestible crude protein and minerals such as Ca, Mg and P (Chukwu et al, 2008; Green, 2003; and Gooding, 1987). Cocoyam also possesses the smallest starch grain size relative to other root crops and tubers (FAO 1990). This makes cocoyam a suitable food for potentially allergic infants, persons with gastrointestinal disorders as well as diabetic patients (FAO, 1990).

One of the problems facing cocoyam is postharvest storage (Chukwu et al, 2008). Cocoyam can be best stored in cool, dry, well ventilated surroundings. The best temperature for prolonged storage of cocoyam is about 7°C. At this temperature, tannia in Trinidad and Taro in Egypt did not deteriorate in storage for over 3.5 months (Kay, 1973; Hashad et al, 1956; Onwueme & Charles, 1994). Storage at lower temperatures leads to death of buds and decay of the corms within two months, while storage at higher temperatures such as 15-23 °C is not satisfactory for long periods (Onwueme & Charles, 1994).

Storage of cocoyam at temperatures around 7°C is not feasible for local farmers and consumers in Africa because of the peculiar high temperature associated with the tropics, hence in many African countries like Cameroun, Egypt and Sonea, cocoyam is stored in underground pits (Onwueme & Charles, 1994). In some communities in southeast Nigeria, cocoyam is stored by being buried under the earth in a cool environment or swamp (Chukwu, et al, 2009). This storage of cocoyam under the earth in a cool dry ventilated surrounding or swamp results in the
sprouting of the corms at the availability of some level of moisture.

Sprouting which is one of the avenues of high physiological losses is characterized by increased enzymatic activities resulting to breakdown of macromolecules and mobilization of reserves from the corm to the growing shoot, which in turn depletes the food nutrients stored in the corm (Wanasondara, et. al, 1999). These processes that take place during sprouting result in the reduction of the eating quality of cocoyam, making them unavailable for consumption, processing and marketing (Nwuo & Atu, 1987). Nwuo & Atu, (1987) also reported 50% loss after two months of storage and about 95% after five months as a result of sprouting. To reduce losses due to sprouting, some farmers practice in situ storage and harvest piece meal to meet consumption and commercial needs. This system ties up the land and restricts use for other purposes (Mbanaso, et. al, 2008; Chukwu, et. al, 2009).

In all the different ways cocoyam is being consumed traditionally, whether by boiling, pounding or as a soup thickener, softening of the cocoyam tuber when cooked is a critical factor which is used to determine its degree of doneness (cookability). However, cocoyam in its various local places of storage usually sprout after some period of time. This sprouting has been observed to affect its cookability and hence its utilization, thus sprouted corms and cormels of cocoyam are used as planting materials rather than eatable materials. This problem reduces the economic value of the sprouted cocoyam and renders farmers economically disadvantaged.

Thus in this study, the effect of sprouting on the cookability of cocoyam tubers was quantitatively investigated in addition to its effect on some physicochemical properties of sprouted cocoyam flour.

**MATERIALS AND METHOD**

**Preparation of the materials:** Four cultivars of cocoyam tubers locally known as 'Coco India', 'Ede Ofe', 'Ede Ocha' and 'Ede Uhie' were obtained from the main market in Owerri, southeastern Nigeria. The cocoyam cormels were identified in the Department of Crop Science and Technology, Federal University of Technology, Owerri, Nigeria. 'Coco India' and 'Ede Ofe' were identified as colocasia esculenta while 'Ede Ocha' and 'Ede Uhie' were identified as belonging to the Xanthosoma sagittifolium. The cormels were carefully selected to remove all cormels with any form of defect or sign of sprouting.

A portion of land consisting of moist rich loamy soil was cleared and tilled into flat beds. The beds were divided into four sections and each cultivar was planted in each section respectively. Samples of the planted cultivar were taken every two days; one portion was used to determine cookability and the other portion was processed into cocoyam flour for determination of physicochemical properties. This continued until complete sprouting occurred. Here, complete sprouting is taken to have occurred when the cocoyam sprout produces a complete leaf.

**Determination of Cookability:** The cookability was determined by the cooking time taken to achieve softness. Six hundred grams (600g) of each cultivar (not planted) was measured out on the zero day of planting. They were peeled and diced separately into cubes of about 1cm thickness. Two hundred grams (200g) of the cocoyam cubes of each cultivar were separately and sequentially placed into an aluminum pot (with a tight fitted cover) of diameter 18.3cm and depth 8.6cm. 400ml of water at ambient temperature of about 28°C was added into the pot to completely cover the cocoyam cubes. The cooking was done using a gas stove with a transparent light blue flame whose power was estimated to be about 225W. The gas stove was left in this state unadjusted throughout the experiment. A stop clock was switched on at the same time the pot was placed on the gas stove. The cooking time was determined as the time interval from the time the pot of cocoyam cubes was placed on the stove to the time the cocoyam cubes were cooked. The cocoyam cubes were considered cooked when they could easily be mashed under slight pressure between fingers (Bede, 2007). To determine when the cocoyam cubes were cooked, a sensory panel of five people who were familiar with the cooking of cocoyam was used, for the tests. Four cubes of each boiled cultivar per panelist were used to test for softness. Preliminary cookings for each cultivar was carried out to determine times when softening of the cubes were to be expected. As a result of the preliminary cooking, the pot was opened once or twice to test for the softening of the cocoyam cubes. The experiment was repeated for the planted cocoyam cultivars which were unearthed at an interval of two days until sprouting was completed.

**Determination of Physicochemical Properties:** 200g each of the different cocoyam cultivars were weighed out, peeled, washed and sliced into thin sizes ranging from 2.0 – 2.5mm on the day of planting considered as the zero day. The cocoyam cubes were sundried and ground into flour using
attrition mill. The flour was cooled and then packaged in an air tight container for subsequent analysis. The planted cocoyam cultivars were unearthed every other day until complete sprouting was observed. The unearthed cultivars were also processed into cocoyam flour using the same procedure.

**Determination of Water Absorption Capacity:** The water absorption capacities were determined by the procedure as described by Onwuka (2005). One gram of cocoyam flour sample was mixed with 10ml distilled water for 1 minute by manual shaking. The mixture was then allowed to stand at room temperature for 30 mins. The volume of the supernatant in a 10ml graduated cylinder was noted and converted to weight by multiplying with the density of water. The water absorption capacities were expressed as gram of water absorbed per gram of ground sample.

**Determination of Oil Absorption Capacity:** The oil absorption capacity was determined by the procedure described by Onwuka (2005). Here, one gram of cocoyam flour was mixed with 10ml of bleached deodorized vegetable oil for one minute by manual shaking. The mixture was then allowed to stand at room temperature for 30 minutes and then centrifuged at 1500rpm for 30 minutes. The volume of the supernatant in 10ml graduated cylinder was noted and converted to weight by multiplying with the density of oil. The oil absorption capacity was expressed as mass of oil absorbed per gram of ground cocoyam sample.

**Determination of Gelation Temperature:** The gelation temperature was determined by the procedure described by Onwuka (2005). Five grams of cocoyam flour sample was put into a beaker. 50ml of water was added into the cocoyam flour and then stirred gently. The beaker containing the mixture was placed on the heater and heated until it started gelling. The temperature at which it started gelling was recorded as the gelation temperature.

**RESULTS AND DISCUSSIONS**

Two cultivars of *Colocasia esculenta* and two cultivars of *Xanthosoma sagittifolium* were used in this work. The cultivars of *Colocasia esculenta* known locally as Coco india and Ede ofe were referred to as ‘taro1’ and ‘taro2’ while cultivars of *Xanthosoma sagittifolium*, locally called ‘Ede uhie’ and ‘Ede ofe’ were referred to as ‘tania1’ and ‘tania2’ respectively.

Figure 1 shows the effect of sprouting on cooking time of the different cocoyam cultivars. The figure shows that the cooking time of all the cocoyam cultivars studied, increased from the 2nd day of planting to the time they attained full sprouting (time the cocoyam sprout produces a complete leaf). It was observed that all the cultivars could no longer cook when full sprouting was attained at 8th and 10th day for Taro1 and Taro2; and 10th and 12th day for Tania1 and Tania2 respectively.
Table 1 shows that sprouting had more effect on the cooking time of the ‘tania’ varieties than the taro varieties. At full sprouting time, the cooking time for tania varieties have increased by an average of 76.5% while for taro varieties, the cooking time increased by an average of 71%. The increase in the cooking time could be as a result of depletion of active starch molecules which were used up during the sprouting process.

The gelation temperature of the different cocoyam flour samples produced is shown in table 1. Gelation temperature for all the cocoyam flour samples increased with days of sprouting. ‘Taro1’ and ‘taro2’ showed similar trend in increase of their gelation temperatures and the same was the case of ‘tania1’ and ‘tania2’. The increase in the gelation temperature of the cocoyam flour samples could also be attributed to the breakdown and depletion of carbohydrate molecules as a result of sprouting thus requiring higher temperatures to form gel. The average percentage increase in gelation temperature at full sprouting for the taro variety (Colocasia esculenta) were almost the same for the Tania variety (Xanthosoma sagittifolium).

Table 1: Percentage reduction or increase in values of cooking time, gelation temperature, oil absorption and water absorption properties of cocoyam flour samples at full sprouting
The variation of water absorption of the cocoyam flour samples with increase in days of sprouting is shown in figure 3. All the samples showed decrease in water absorption with increase in days of sprouting. ‘Tania2’ showed the least water absorption capacity at full sprouting time. This may suggest the reason why it had the highest cooking time among the cultivars, as cookability is dependent on water absorption. The decrease in carbohydrate molecules as a result of sprouting activities could have resulted in the reduction of the amount of water absorbed by the flour samples.

The cultivars of *Xanthosoma sagittifolium* (‘tania1’ and ‘tania2’) showed similar trend in their oil absorption capacity as days of sprouting increased (figure 4). For the *Colocassia esculenta* cultivars, ‘taro1’ showed lower oil absorption than ‘taro2’. In general, the results obtained were in line with previous works which showed that sprouting has significant effect on the chemical, functional and pasting properties of flours produced from sprouted grains and nuts (Chinma, *et. al*, 2009; Hussain and Burhan Uddin, 2012).
Reduction in water and oil absorption of the cocoyam flour samples indicate that sprouting reduces the thickening power of cocoyam. However, from table 1, the relative low percentage reduction in water and oil absorption of about 28% and 23% respectively in taro and about 42% and 36.5% respectively in Tania on the average suggest that sprouted cocoyam corms and cornels could still be utilized as a soup thickener when converted to flour, only that more quantity of the flour would be required to achieve desired effect.

Processing sprouted cocoyam corms and cornels to cocoyam flour will not only make it possible to utilize them as food but will also add more economic value to them, which will be an advantage to the farmers.

CONCLUSION

Sprouting affects cookability of cocoyam cultivars. This invariably affects their utilization for local uses in different food delicacies. The flour produced from the corms and cornels of sprouted cocoyam showed relatively low percentage reduction in water and oil absorption. The use of cocoyam as thickener depends on their cookability which is adversely affected by sprouting. Cocoyam flour produced from sprouted cocoyam corms and cornels could still be used as an alternative soup thickener for the traditionally cooked and pounded cocoyam dough, as the sprouted cocoyam flour still showed pronounced ability to absorb water and oil which are important factors as far as soup thickeners are concerned.

REFERENCES


