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Innovative Development of Cassava Processing Machine as Solution to Crisis against Agricultural Systems

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Introduction

Maize and cassava (*Manihot esculenta* Crantz) are the most important sources of calories in sub-Saharan Africa (Haggblade *et al*., 2012). A degree (1°C) increase in temperature can reduce maize production by 17% (Oseni and Masarirambi, 2011). The rising world average temperature and unpredictable rainfall are threatening global food grain supply (Kolawole, 2012). For many African countries, investment in irrigation for production of staple food grains is financially difficult. Cassava gives reasonable yield under marginal soil conditions and it is tolerant of drought (Kolawole *et al*., 2010). For this reason, it is rapidly overtaking maize and other food grains as an important staple food in many parts of Africa, stabilizing the food security status of the poor. However, cassava roots cannot be stored for too long. Cassava is best stored in the form of flour. High quality cassava flour (HQCF) can conveniently replace maize or wheat flour (Abass *et al.,* 2011). Many food products (Figure 1) can be made from HQCF. The inclusion of HQCF in wheat flour can significantly reduce the huge food import bills in Africa (Adesina, 2012).

Figure 1. Food product from cassava

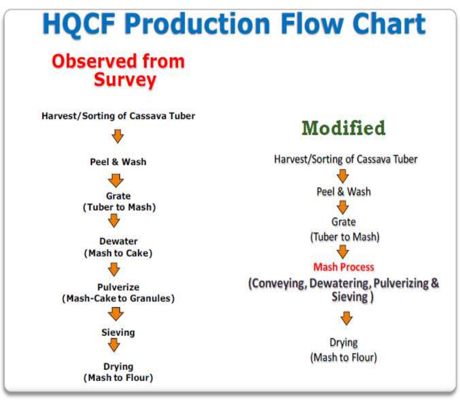

Figure 2. Peeling of cassava tuber by women

Producing HQCF from cassava roots at the village level involves peeling, washing, grating, dewatering, pulverizing, sieving/sifting, and drying. Tools for processing HQCF require innovation. Peeling cassava roots immediately after harvesting is a difficult operation, mostly done by women (Figure 2). Hand peeling is currently the only feasible option (Sanni, 2004). Grating cassava roots to mash can effectively be done with powered graters. Dewatering the mash is another tedious operation. The traditional method involves packing the mash inside polypropylene sacks and pressing with heavy stones for 24 – 48 hours. Improved dewatering is done with a mechanical press to apply pressure on polypropylene sacks that contain the grated cassava mash within 2-4 hours. Constraints to cassava processing include the absence of appropriate processing machines at the village level. The traditional operation allows skin contact with the cassava mash. All cassava tissues contain toxic cyanogenic glycosides (McMahon *et al.*, 1995). Mash process stages expose workers to ailments and disorders of ergonomic origin (Fajemilehin and Jinadu, 1992). The use of raffia sieve (Figure 3) for pulverizing and sifting cassava cake during flour processing is unhygienic and hazardous (Sanni *et al.*, 2008). Innovative development of cassava processing machines can help stimulate agricultural growth. Attempt was made to combine the efforts made so far.

Figure 3. Conveying, dewatering and sifting

Material and Methods

The parameters affecting dewatering of cassava mash during processing were evaluated using fabricated experimental equipment and existing models. IITA TMS 4(2) 1425 variety at three levels of maturity, i.e., 9, 12, and 15 months after planting, was used in the study. Parameters studied were pressure drop, face area of the filter medium, and mash resistance. The mash resistance varied with the age of the cassava: the highest value was 5.4×10^{11} m/kg. Medium resistance also varied with the age, 3.3×10^{11}/m. The volume of filtrate, $3.71 \times 10^{-3} m^3$, was obtained from the 12-month-old sample with 9.45×10^{-2} kg mash cake deposit on the filtering medium. The Kozemy constant (Ko) value for TMS 4(2) 1425 variety was found to be 1.14×10^7 and porosity of mask cake was 0.0181 at 50% moisture content wet basis. These parameters were used in the modification of existing flow chart (Figure 4), and the mash processes of conveying, dewatering, pulverizing, and sieving were combined into one machine.



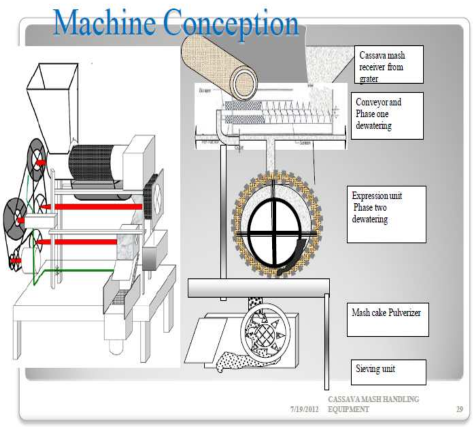


Figure 4. Process flow chart

Figure 5. Cassava mash process machine concept

This was translated into workable machine components for further development (Figure 5).

Figure 6. The machine Prototype

Results and Discussion

The newly introduced mash process machine combined conveying, dewatering, pulverizing and siefting (Figure 6). The result obtained show that slow screw speed yielded a smaller volume of liquid (Figure 7). Decreased throughput was observed with increase in screw speed (Figure 8). Conversely high screw speeds produced wetter solids and short resident times (Figure 9). The recovery of solids from liquid improves with the introduction of a 300 N spring force as back up. There was an increase in temperature of sample at higher speed (Figure 10) also at higher spring force. The results show that the higher the feed screw speeds, the lower the machine efficiency. Higher temperature could lead to gelatinization of the mash. Heated mash is unsuitable for HQCF. The best result was obtained at moderate screw speeds of between 40–50 rpm at a spring force of 200 N. The product moisture content was reduced from 68% to about 47% moisture content wet basis. This innovation includes pulverizing of the cake as part of the process.

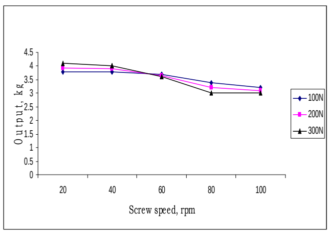


Figure7. Output/ circle

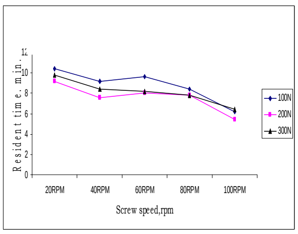


Figure 8. Expelled juice

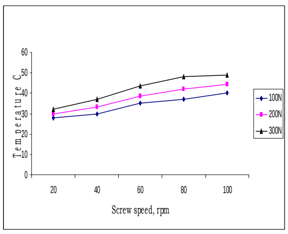
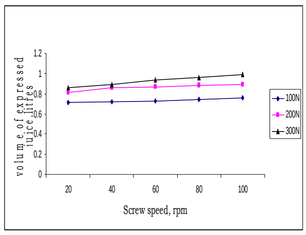


Figure 9. speed and temp.



F10 speed / resident time

Conclusions and Outlook

Food security is the right of all people to healthy and culturally appropriate foods. Bakery flour requirement can now be met with HQCF without depending entirely on imported grains. Africans need good cassava processing machines. Innovative mechanization will allow processors to produce the flour without drudgery. Innovative development of other cassava processing machines will be needed. Commercial development of this machine will improve food security in the face of climate change-induced agricultural calamities.

Acknowledgements

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