ABSTRACT

A cassava mash process handling machine was developed and tested. Studies were conducted on the effect of screw speed at 20rpm to 100rpm at 20rpm interval. Back pressure was induced by the use of spring of 100N, 200N and 300N. Using a TMS 4(2)1425 variety of cassava, the performance of the screw press unit of the machine was evaluated. The operating parameter of the machine at 40-50 rpm produce a mash with an average moisture content of 52% moisture content wet basis. With the back pressure set at 200N as the machine standard.

Key words: Screw press, Cassava mash dewatering and HQCF.

1. INTRODUCTION

Cassava (Manihot Esculenta Crantz) is an important food security and income generation crop for households in many countries of sub-Saharan Africa. The tubers of cassava cannot be stored for too long. Processing follows immediately into flour and gari. Cassava mash made by grating peeled cassava is fermented before dewatering to produce gari. Unfermented mash is dewatered and dried to produce High Quality Cassava Flour (HQCF). Traditional tools were the options available for the mash process. The use of automobile hydraulic jacks for cassava mash dewatering is very popular. Other traditional materials for mash processing include sack, baskets, pestle and mortar. The result of using these traditional methods is low productivity, the method involves uncalculated movements, dewatering of cassava mash from about 70% moisture to form mash cake of about 47% moisture content wet basis within a short time, breaking of the cake to granules and drying of the mash to flour. Rapid cassava mash dewatering was described as a major problem in the production of HQCF (Abass et al., 2003). Present method of processing mash into cake is in batches. These operations require a handling machine to reduce skin contact and increase production. All cassava tissues, with the exception of seeds, contain toxins known as cyanogenic glycosides (McMahon et al., 1995). Prolonged contact of this toxin with human skin could lead to diseases (Arbogast, 2006). A hydrogen cyanide concentration of 300 mg/m³ in the air will kill a human within about 10 minutes (White et al., 1998). Exposure to lower levels of cassava cyanide over a long period can result in weakness and a variety of symptoms, including permanent paralysis (Oyegbami et al., 2010; Oboh, 2004). Cyanide exposures are typical during cassava processing stages. Each of the mash processing stages exposes workers to various occupationally related ailments and disorders of ergonomic origin (Fajemilehin and Jinadu, 1992).

Presently, there is no continuous wet milling process machine for cassava mash. Therefore, a combined mash process handling machine was proposed for developed (Kolawole et al., 2010). Screw press is the best dewatering equipment for high moisture material (Moller et al., 2000). The pressing action of screws depends on solids blinding the perforations of the press screen (Albertson et al., 1991). Cassava mash contains very small traveling particles that can block filter holes during dewatering, the particles are capable of creating some resistance to fluid flow (Kolawole et al., 2007). Screw press was considered for the mash dewatering operations in the design. The objective of this paper is find out if the screw press can effectively remove moisture from cassava mash this was determined by evaluating the performance of the filtration unit.
Figure 1: Pictorial View of Wet Cassava Mash Handling Machine

Figure 2: Orthographic Drawing of Wet Cassava Mash Handling Machine.
2. METHODOLOGY

The performance evaluation of the filtration unit of mash handling machine was carried out when the construction of the machine had been completed as shown in plate1. All the parts were properly set and bolted together. The screw was encased in dual steel screens. The inner screen was made of cloth. It has fine perforations towards the end of the screw. Collected fluid was allowed to flow along the outer screen into the collection duct. Cassava tuber TMS 4(2)1425 variety of 11 months old was harvested from Plot ES16 at IITA farm. The tubers were peeled and washed and grated into cassava mash at IITA cassava processing centre. Convectional method of moisture determination was used to determine the mash moisture content. The prepared mash was divided into samples by the use of weighing scale. The machine was run with 20kg of mash to provide for the stabilization and sealing perforations. The machine was operated for 30 minutes, and then stopped. The experiment was conducted with 10kg sample of mash into the fabricated machine system (11) shown in figure 1.

Measurement of time was done using a stopwatch. The moisture content of the product was measured during the experiment with moisture metre Traceable Hum. /Temp. /D.P. Meter Model 4080 and re confirmed with conventional method for accuracy. Tabletop Digital Scale Standard Precision Model SC-30 was used. Temperature of sample was monitored using CXTG-3000, Temperature PROBE and confirmed with EXTECH instrument 42525A Infra-red/Type K thermometer with laser pointer. The total output per round of test in kg was measured by weighing the product obtained from the machine.
Table 1: EXPERIMENTAL PLAN FOR DETERMINING EFFECT OF SPEED AND BACK PRESSURE

<table>
<thead>
<tr>
<th>Variables</th>
<th>Level</th>
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<tbody>
<tr>
<td>Machine Speed</td>
<td>20, 40, 60, 80, 100 RPM</td>
</tr>
<tr>
<td>Back Pressure Spring Tension</td>
<td>0N, 100N, 200N &amp; 300N</td>
</tr>
<tr>
<td>Cassava Variety</td>
<td>TMS4(2)1425</td>
</tr>
</tbody>
</table>

Plate 2: Back Pressure Spring

The machine was evaluated using six screw press (see figure 2) speeds, ranging from 20 rpm to 100 rpm at an interval of 20 rpm by changing the belt on the pulley. The machine was powered with a 350 Watts single phase electric motor at 1450 rpm. The speed was reduced with appropriate pulley ratio within the belts arrangement. Back pressure springs of tension 100N, 200N and 300N were selected (as shown in Table 1) using 8S 2263 caterpillar service tool spring tester. Selection of the rpm was done by replacing belt positions.

2.1 Experimental Procedure

The stabilisation conducted with 20 kg of the grated mash sample enables easy passage of the sample. An experimental sample of 10 kg at five replicates was measured out. The samples were fed into the machine at each given speed. This was done five times per selected back pressure spring shown in Plate 2. No spring, 100N, 200N and 300N were all verified at the screw speed of 20-100 rpm. The back-pressure system located just before the discharge point was varied by replacing spring to adjust the dryness of the solids. Mash sample enters from inlet end of the screw and move against the pressure of the back plate hosting the spring.

Figure 3: Screw press speed and mash moisture at each giving back pressure
Time spent by mash in the Filtration unit

Figure 4: Average processing time of Cassava Mash

Mash Temperature Vs Speed of screw

Figure 5: Showing average product Temperature at the spring load

Mash output

Figure 6: Mash output
3. Results

The result indicated that barrier made with spring to create back pressure is highly significant in the design. It made dewatering possible as the mash movement was obstructed. This created restriction that lead present to dewatering pressure. In figure, no spring force created any pressure, therefore no dewatering. A slow screw speed yielded drier solids as shown in figure 3. The drier solids were obtained at the other end, a decreased throughput was observed in figure 4. Conversely high screw speeds produced wetter solids as shown in figure 3. The recovery of solids improves with 300N spring but the temperature increase in figure 5 will not make it suitable. The obtained results revealed that the higher the machine speeds, the lower the machine efficiency (figure 6). Therefore, the choice of speed for the machine will be compromised between capacity and quality. Screw speed has significant effect on the product temperature. Higher temperature could lead to gelatinization of the mash which is not good for flour production. The best result was obtained at moderate screw speeds of between 40-60rpm with a spring force of 200N. The product moisture content was reduced from 68% to 52% moisture content.

4. Conclusion

The positive concern to generate income from cassava products is now brighter as conveying, and filtration dewatering can be done with machine. There is a concern for product temperature and cake of lower moisture. Increases in operational speeds do not increase the production rate but generate heat by increasing the machine and product temperature. Additional effort would be needed to further reduce the mash cake moisture by expression without increase in the temperature. The mash process handling machine when commercially produced will enable cassava processors in sub-Saharan Africa to produce popular products for the market. This machine must be scaled up and mass produced to reduce drudgery and allow the cassava processors to get their businesses off the ground.

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