Journal of Bioinformatics and Sequence Analysis Vol. 3(2), pp. 23-30, February 2011
Available online at http://www.academicjournals.org/JBSA
ISSN 2141-2464 ©2011 Academic Journals

Full Length Research Paper

Evaluation of cassava mash dewatering methods

Oladele Peter Kolawole[1,2]*, Leo Ayodeji Sunday Agbetoye[1] and Agboola Simeon Ogunlowo[1]

[1]Federal university of Technology Akure, Nigeria.
[2]International Institute of Tropical Agriculture, Ibadan, Nigeria.

Accepted 25 August, 2010

Using different cassava maturity age of 9, 12 and 15 months, evaluation study was carried out on cassava mash dewatering methods. Dewatering tanks with square and cylindrical shapes were made with steel for the experiment. Pressure devices from screw bolts, hydraulic jack press and rope / stick methods were used to squeezed cassava juice from the mash in the tanks. TMS 4(2) 1425 variety of cassava was used. Cylindrical tank containing a 12 months old sample with hydraulic jack gave mash cake with moisture content of the sample at 44% wet basis in the shortest time.

Key words: Dewatering, screw press, hydraulic press, cassava mash.

INTRODUCTION

Cassava is a major source of carbohydrates in human and animal diet; other areas of uses of cassava are being implored. The crop tolerates many cultivation processes, this make its cultivation more popular. The tubers of cassava cannot be stored longer after harvest before decaying, so processing follows immediately after harvesting; this involves peeling, grating, dewatering, cake milling and sieving. The mash can be transformed into two principal products, flour and gari after dewatering. Proper dewatering method to obtain the best product is a requirement, added to this factor is the high cost of fuel needed for drying flour or frying of garri. The engineering improvements required for cassava processing into food depends on the development that can be given to the traditional equipment technology, with the aim of developing low cost with low energy demanding equipment. Traditional processing procedures aimed at reducing cyanide, improving storability, providing convenience and palatability. These starts with dewatering methods adopted. Cassava contains about 70% moisture content, which must be reduced to acceptable level; this process may include fermentation, with the dewatering taking place-using available and suitable methods. Some with stones placed on the sack (Figure 1) or with the use of jacked-wood platforms (Figure 2) to press off the excess liquid from the pulp (Igbeka et al., 1982). The objective of this paper is to evaluate some commonly use-dewatering systems, showing their merit and demerit under different cassava maturity in order to predict areas requiring engineering improvement. The results obtained can lead to understanding and need for better-developed process handling equipment. This is vital as cassava food is becoming commercialized leading to higher demands for its flour.

Literature review

Dewatering in cassava processing involves applying pressure on the grated pulp to reduce its moisture content. In the dewatering of cassava mash, the particles are constrained while the liquid is free. The pressure applied, varied depth, time, moisture content, volume of material and the particles of material, these are some of the parameters identified by Kolawole et al. (2007). The material moisture content, the mass and the volume were easier to identify.

Diop (1998) reported that the Amerindians developed an ingenious press shaped like a long thin basket-weave tube called *´tipiti'*. The operation of the tipiti-involved fillings it with cassava mash, hung on a branch of a tree and stretched from the bottom; the reduced volume at the base reduces the mash volume, water is then squeezed out of the mash. Some other methods involves placing of heavy stone on top of the mash and this was used by Ajibola (1987) when he places heavy stone on cylindrical tank filled with cassava mash to effect dewatering mechanically.

Operation of dewatering is mainly carried out manually

*Corresponding author. E-mail: P.KOLAWOLE@cgiar.org.

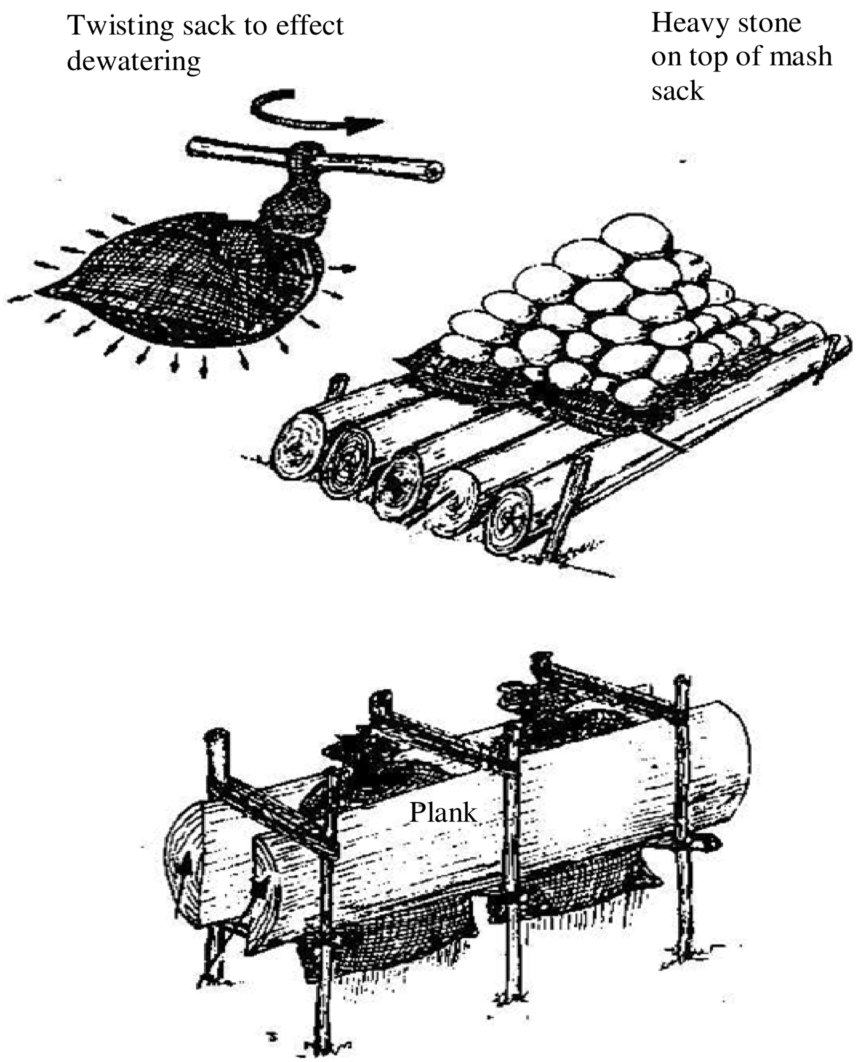

Figure 1. Traditional methods of pressing and fermentation (Diop, 1998).

under rural conditions. So many methods are in use for cassava mash dewatering as; boulders or logs method, use of sticks, parallel board method, tree stumps method, chain or string methods and screw jack (Kolawole and Agbetoye, 2007). Pressing cassava mash have been industrialized with hydraulic presses providing pressures of up to 25 kg/cm^2 (Igbeka et al., 1982) the pressing time can be as short as 15 min with the hydraulic press or as long as 4 days or more when stones are relied upon the only one available to the the local processors in some locality. The main reason for dewatering in cassava mash is same in all crops processing to food; it is a pre-drying alternative (Sinha et al., 2000). Study of centrifugation and direct pressure as means of dewatering was done for cassava starch production by Klanarong et al. (1999). Straub and Bruhn (1978) used a comparison study of centrifugation and direct pressure as dewatering means, while studying the dewatering characteristics of alfalfa protein concentrate. The result indicated that comparable dewatering could be obtained. Increased acceleration or increased holding time did not give large decreases in final moisture content of the sample.

The improved and available process of cassava mash dewatering could bring about faster rate. They are in the form of a circular press cage holding the fresh pulp or square frame exerting pressure on the sacks**.** Many types' works by moving a heavy circular or square block, which is lowered or raised by means of, threaded shaft. Some design of press uses hydraulic jack used for cars or lorries to apply pressure to the mash (Igbeka et al., 1982). The frame may consists of two vertical metal posts as shown in Figure 2, all require some amount of human effort to operate them, this in turn compressed the mash to cake. Compression of mash into cakes results in the increasing resistance of cakes. Cassava mash cake is compressible and their specific resistance α change with

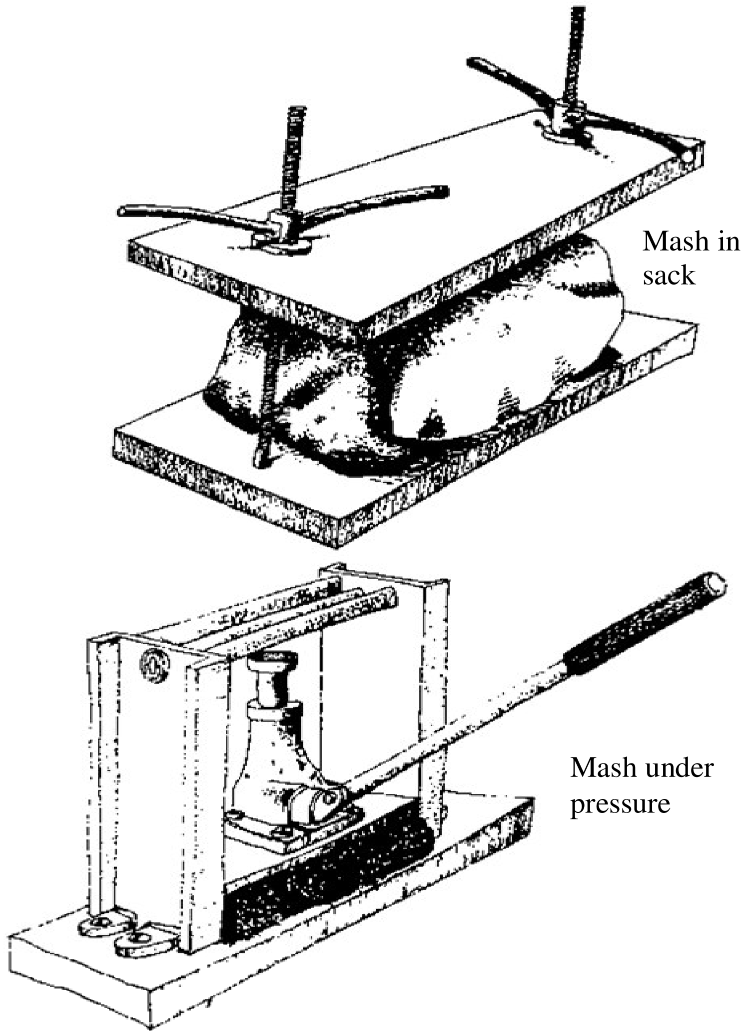

Figure 2. Jack method (Diop, 1998).

the pressure drop across the cake Δp_c as reported by Kolawole (2005).

With constant pressure operations the function:

$$\alpha = f(\Delta p) \quad (1)$$

may be employed directly. Using the equation

$$\Delta p = \Delta p_c + \Delta p_m \quad (2)$$

Where $\Delta P m$ = Pressure drop across the medium; $\Delta P c$ = Pressure drop across the cake; ΔP= Pressure drop. With μ as the viscosity, R as the sack resistance, Q as the flow rate of the juice, A as the pressure operating area, the average mash cake resistance α_{av} and the mash cake $\boldsymbol{c}$ concentration playing a role. Then the pressure across the filter medium becomes:

$$\Delta p_m = \frac{\mu R Q}{A} \quad (3)$$

The pressure on cassava mash cake, becomes

$$\Delta p_c = \alpha_{av} \frac{\mu c V Q}{A^2} \quad (4)$$

MATERIALS AND METHODS

Materials

Experimental equipment was designed to obtain the applied pressure, such away that it can be used with the rest of the selected devices. The conception was based on ideas and discussions made during brain storming section with IITA farm engineering staff. An hydraulic system of confining liquid in a tube was the choice in sensing the pressure differences using Pascal's

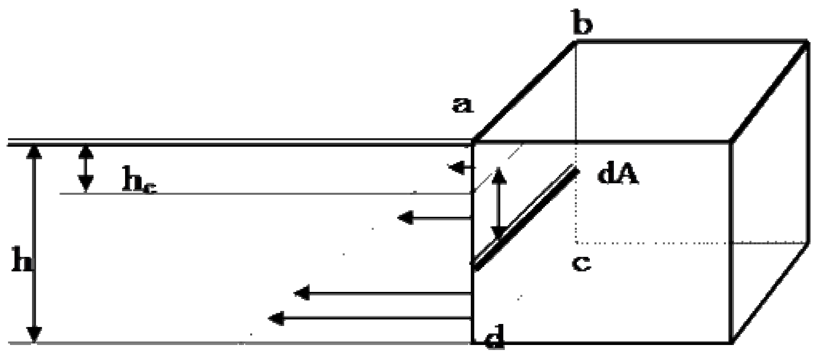

Figure 3. Pressure on the experimental box walls.

Principle, which states that pressure transmitted is undiminished in an enclosed static fluid:

$$P_2 = P_1 + \rho gh \quad (5)$$

Where ρgh is Static fluid pressure P = F/A expressed in N/m^2 as the force acting normally on a unit area. Equal pressure throughout the area of confinement is characteristics of any pressurised fluid were used as means of obtaining the value of applied pressure, (Sperry and Vickers 1979). Where a fluid exhibits pressure- driven flow, we get:

$$\frac{p_1 - p_2}{\rho g} = \frac{\Delta p}{\rho g} \quad (6)$$

Darcy – Weisbash friction factor *F* (viscous forces divided by inertial forces). The pressure due to a fluid pressing against a body tends to compresses the body. The ratio of the pressure to the frictional decrease in volume is given as:

$$B = \frac{P}{\Delta V / V} \quad (7)$$

Where B is the Bulk modulus. Mash decreases in volume when they are subjected to external pressure. A minus sign was introduced in the equation to make B positive. The pressure extended by a fluid is equivalent to a compressive stress

The fraction decrease in volume - $\frac{\Delta V}{V}$ is compressive strain.

The inverse of the bulk modulus is compressibility K:

$$K = \frac{1}{B} = -\frac{\Delta V / V}{p} \quad (8)$$

The absolute pressure is obtained from gauge pressure by adding atmospheric pressure to it

P = P[gauge] + P[atm.] but Poiseuille's law of flow of liquids through a tube:

$$v = \pi r^4 p/8cl \quad (9)$$

Where: ***l*** = the length of the tube in cm, *r* = the radius of the tube in cm, *p* = the difference in pressure of the two ends of the tube in dynes per cm^{2,} ***c*** = the coefficient of Viscosity in poises (dyne-seconds per cm^2), ***v*** = volume in cm^3 per second.

Also put into consideration during the design is the bought out components, which was designed for pressure measurement, pressure gauge for measuring pressure above atmospheric. Spring-element pressure gauge was used for this experiment as bought out item. The sealed end connected to a pointer, the deflection shows the pressure of the fluid from the experimental box connected to the nipple of the gauge. Pressure on the walls of the box was considered (Figure 3). Pressure on one side is the same as the pressure on other sides In finding the direction of the resultant force R pressure on one side of the wall abcd ab =bc=cd=ab = 0.3 m.

Area of the wetted surface of abcd = A; Hieght of liquid in the box= h; h_c =distance of centroid of the wall from the free surface.

$$P_{max} = \rho gh + P_o \quad (10)$$

P_{max} is the maximum pressure expected on the samples, Pressure at the centroid the area:

$$P_c = \rho gh_c \quad (11)$$

Then pressure on the constant element dA:

$P = P_c + \rho hz$

Where z is the ordinate of Area dA

The total force $R = \int PdA$

$= \int (Pc+Pgz)dA$

$= Pc\int dA + \rho g\int zdA$

$= PcA + 0$

$R = PcA$ or $(h_c\rho g + P_o) \times A$

Pressure on the wall of the copper tube with a diameter D wall thickness t and a minimum tensile strength of 205 N/mm^2 per unit area at any point on the tube was considered and used for the experiment, the actual tensile stress was not expected to be more than the permissible stress. Expected failure points were near two surfaces of the diametrical cross section.

Each of them has an area:

$$A = t\ell \quad (12)$$

The tensile stress in these areas are:

$$= pD\ell/2\ell t, = pD/2t \quad (13)$$

Table 1. Design/layout.

Cassava variety	Number of sample	Container shape	Dewatering method
IITA TMS 4(2) 1425	C9 C12 C15	Cylindrical	Rope/stick
	C9 C12 C15	Square	
	C9 C12 C15	Sack	
IITA TMS 4(2) 1425	C9 C12 C15	Cylindrical	Hydraulic
	C9 C12 C15	Square	
	C9 C12 C15	Sack	
IITA TMS 4(2) 1425	C9 C12 C15	Cylindrical	Screw
	C9 C12 C15	Square	
	C9 C12 C15	Sack	

The permissible strength was found grater than the calculated tensile stress. Further, the deflection of the material that host the pressure was calculated by using $wl^4/384EI$ Where w is the force on the longest part, *l* the length of box *E* young' modulus and Moment of Inertia**.** $I = bh^2/12$.

Experimental tool calibration and verification

Objects of different mass were used to exert pressure on the equipment tool; six different gauge types were used. Several weights of objects were tested with the equipment including the weight of workshop staff on top of the platform; these readings were the same for the repeated measurement readings. A measured variable was compared to a reference variable from those earlier measured at pressures of 40, 50, 70 and 80 KN/mm^2 using workshop press. During the calibration process, the measurement system was balanced in such a way that the measured variable deviates as minimally as possible from the true value (reference value), and is within the tolerance range. Measuring device was verified on the basis of what is obtained from hydraulic presses in the workshop and at post harvest unit of IITA. A confirmation of verification-specific, such as verification error limits, was not breached. A verification group within the workshop additionally identifies the measuring device before the commencement of the experiment.

Method

Dewatering was effected using two tanks made of 1 mm galvanized steel plate. The tanks were drilled at the base with 7 mm diameter drill to provide passages for the fluid flowing from the mash. Grated cassava mashes in sacks, in the square and cylindrical containers, were tested with screw bolts, hydraulic jack press and rope / stick methods. The procedure involve each of cassava-grated samples dewatered with the mash carefully and measured at 10 kg into a well-labeled sacks as shown in table one.

The purpose of putting the mash in a sack was to provide filtration at all sides at the same time preventing upward seepage. The sample tanks keep the same standard, since the sacks can be moved out of the containers easily.

For dewatering methods and effect of container shape, each had nine treatments and repeated 5 times this was varied with the age of cassava. The best method was discovered from the most efficient, the best to meet set moisture content required at a given time for gari production.

Material mass and height measurement

The heights of samples were measured using steel rule before dewatering and after the experiment. Mass of samples was also obtained by weighing the container and sample before and after the experiment.

Applied pressure

The pressure applied was read from the gauge in the experimental equipment. The samples in the dewatering tank placed on the equipment with the pressure applied using a hydraulic jack, screw and rope/sticks methods at different time. The observed pressure reading from the attached pressure gauge was recorded (Table 1).

Time/volume of liquid

The measurement of time was done using a stopwatch. The starting time noted with the volume of expressed liquid. The pressure was kept constraint at the pick, for every 30 s as the liquid gradually drops in flow rate the change in volume is always noted. The cumulative filtrate volume and time presented in data sheet.

Moisture content of samples

The moisture content of the cassava mash samples was noted before and after the experiments. The moisture content of samples was obtained by drying the samples in an oven at 100°C until no further change in weight occurred. This took three days of 70 – 72 h in a try-temp hot pack oven and weighing took place daily.

Cassava mash resistance

Mash resistance was noted as internal resistance developed as opposed to applied pressure, only determined with calculation from the data obtained when a constant pressure operation was carried out on the samples.

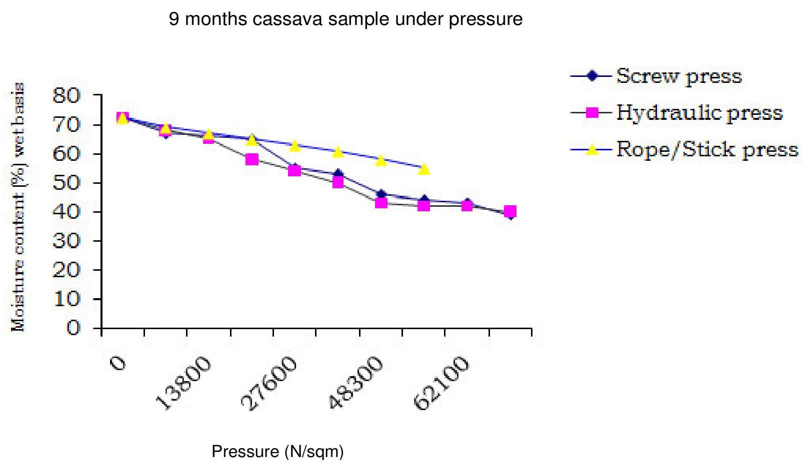

Figure 4. Effect of pressure application on 9 months old graph.

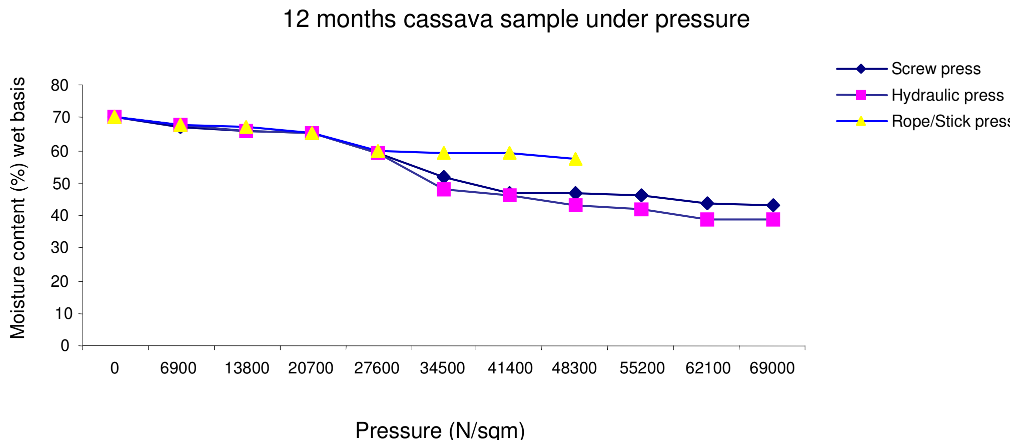

Figure 5. Effect of pressure application on 12 months old graph.

Filtrating surface area

Dewatering tanks made into shapes that the filtration area was calculated with ease, the base area of containers in use when pressure was applied to the mash during the experiment.

RESULT

TMS 4(2) 1425 variety of cassava was available in large quantity for the experiment the chosen variety is of known value of garification as reported by IITA (1987).

Effect of type of container

Grated sample of cassava mash in container was used in testing square and cylindrical container by applying pressure, the statistical analysis using t-test for related measures t=1.8999 df=N-1 at 0.5 level gives 2.262 which is smaller, that proved that cylindrical container performed better as the moisture content of the sample in cylindrical container meets the set standard of 40 to 45% moisture content wet basis in shortest time.

Effect of applied pressure

Samples tested from screw, hydraulic jack press and rope/stick methods, the result obtained using the cylindrical container with the hydraulic jack pres**s** reduce the moisture content of mash to the acceptable level for garri production at a pressure of 69000 N/m^2 while the method of rope/sticks gave the poorest result in the experiment carried out, the required moisture content for garri production process was expected to be 40 to 45% mcwb. Obtained result from the rope/stick and sack method at 20700 N/m^2 was 58.7% mcwb. Advancing beyond this pressure point was difficult. Using hydraulic jack at 48300 N/m^2, 44% moisture content was obtained Figures 4, 5, and 6.

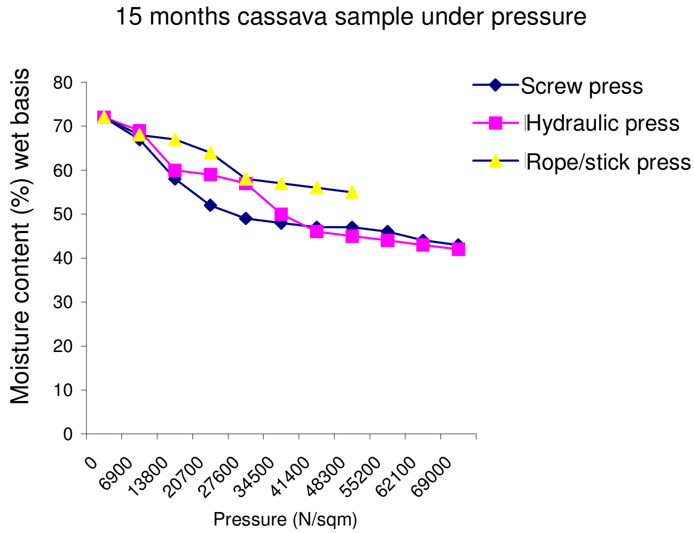

Figure 6. Effect of pressure application on 15 months old graph.

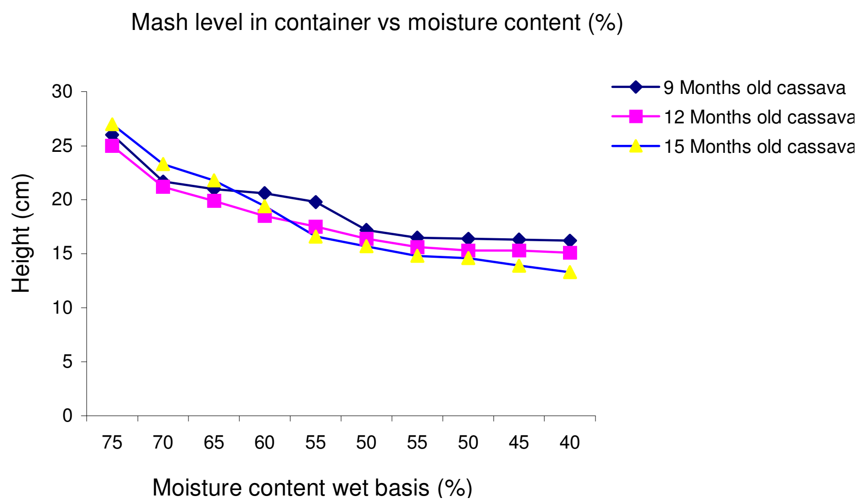

Figure 7. Graph of mash level in container after dewatering.

Effect of cassava age on the dewatering

The volume of filtrate obtained from the samples show that the C9 contains more water than the C12 and C15 at the start of the experiment but C12 had more fluid at the end, this may be due to maturity at peak for the variety while C15 compressed more than the C9 and C15 as shown in Figure 7 this can be due to fibre formation within the cassava.

Conclusion

The results obtained show that not much pressure can be sustained by stick/rope method, as more time will be required. The screw and the hydraulic methods are very efficient. The hydraulic jack method of dewatering shows clear efficiency with the C12 sample as shown in Figures 4, 5 and 6, but no significant differences were noticed between the screw jack method and hydraulic methods when used on C9 and C15 samples. This confirms Igbeka et al. (1982) statement that screw presses and jack presses are used for greater efficiency and speed.

REFERENCES

Ajibola OO (1987). Mechanical Dewatering of Cassava Mash; Transactions of ASAE, 30(2): 539-542.
Diop A (1998). Storage and Processing of Roots and Tubers in Tropics; Food and Agricultural Organisation of UN Agro-Industries and Post-

Harvest Management Service Agro Supports System Division. www.fao.org/docrep/x5415e/5415e00.HTM.
Klanarong S, Sittichoke W, Rungsima C, Sunee C, Kukakoon P, Christopher GO (1999). An Improved Dewatering Performance in Cassava Starch Process by A Pressure Filter, Kasetsart Agricultural and Agro-Industrial Product Improvement, Kasetsart, University Thailand. http://cstru.00go.com/1999/1999_03.htm.
FAO (1994). African Experience in the Improvement of Post-harvest Techniques, Food and Agricultural organization of the United Nations, Agricultural Engineering service (AGSE) Support Systems Division Workshop, ACCRA, Ghana 4th to 8th July, Rome, Italy.www.fao.org/docrep/W1544E/W1544E07.HTM.
Igbeka JC, Jory M Griffon D (1992). Selective Mechanization for Cassava Processing. Agricultural Mechanization in Asia, Africa and Latin America, 23(1): 45-50.
IITA (1987). Elite Cassava Clones Assessed for Gari Quality. IITA Annual Report and Research Highlights. Ibadan, pp. 96-97.
Kolawole OP (2005). Investigation into Cassava Mash Dewatering Parameters Unpublished Master of Engineering Thesis, Agricultural Engineering Dept. Federal University of Technology Akure.
Kolawole OP, Agbetoye LAS, Ogunlowo AS (2007). Cassava Mash Dewatering Parameters. Int. J. Food Eng., 3(1): 4. http://www.bepress.com.
Kolawole OP Agbetoye LAS (2007). Engineering Research to Improve Cassava Processing Technology, Int. J. Food Eng., 3(6): 9. http://www.bepress.com
Sperry V (1979). Mobile Hydraulic Manual, M-2990A, 2nd Edition Sperry Corporation, Troy Michigan 48084, p. 4-20.
Straub RJ, Bruhn HD (1978). Mechanical Dewatering of Alfalfa Concentrate. Transactions of ASAE, 21(3): 414-421.