PERFORMANCE EVALUATION OF A CASSAVA PELLETING MACHINE POWERED BY A DIESEL ENGINE

Nwaokocha Collins*, Layeni Abayomi, Giwa Solomon, Yusuf Rasheed & Adebayo Kolawole.

Department of Agricultural and Mechanical Engineering, College of Engineering and Environmental Studies, OlabisiOnabanjo University, Ibogun Campus, P.M.B. 5026, Ifo, Ogun State, Nigeria.

**Corresponding Author: collinsnwaokocha@oouagoiwoye.edu.ng, collinsnwaokocha@gmail.com*

ABSTRACT

This study presents the performance evaluation of a pelleting machine designed and fabricated for the production of cassava pellets. Cassava pelleting is a process by which cassava mash and other animal feed ingredients such as groundnut cake, are compacted in a barrel and propelled out through a die opening by mechanical process. The machine consists majorly of hopper, extrusion chamber (barrel), diesel engine, die, cutter and a stand. The machine is powered by a diesel engine to cater for rural settlement where there is insufficient power supply. The machine showed higher throughput capacity of 19.28 kg/hr with a maximum pelletizing efficiency of 89.33%. Factors that determine the quantity and the quality of the extrude rates are the feeding rate and the amount of moisture content. Output results increases with the absence of disturbance and regular feeding. Adopting the pelletizing machine by small and medium scale farmers would help them in producing their own feed with local contents thereby alleviating the problems associated with the sourcing of imported feeds.

Keywords— *Extrusion chamber, Feeding rate, Hopper, Pellets, Pelletizing efficiency.*

Accepted date: 25 June 2017

INTRODUCTION

Overtime, it is an established fact that animals are fed in primitive ways – either domestic or wild animals (FDF, 1995). These feeds are deficient of standard diet content, which leads to poor growth, poor development, muscular weakness and increase in susceptibility to many diseases (FDF, 1995; Nwaokocha & Akinyemi, 2008; Ojomo et al., 2010). Due to advancement in technology, grinding machines were developed for grinding of cereals and grain with the mixture of other nutrients into powder form. With time, it was discovered that animals preferred feeding on solid and soft nutritious meals. One of the devices that can produce this requirement is called a pelletizing machine (Nwaokocha&Akinyemi, 2008).

Pelleting is the moulding and compressing of materials of powdery, flaky and bulky structures into pellets using machines. Pellets come in various ranges and shapes: Triangular, Cylindrical or Oval, (Harper, 1981, 1978; Ojomo et al., 2010; Rosen, 1973; Schultz, 1990; Slater, 1984). Pelleting is a process whereby several ingredients such as cassava mash, soya beans and some other animal feeds substances are compacted and forced out through die opening by mechanical process. Pelletizing machines are built to perform the following functions, viz - mould animal feed meals in form of soft capsules, which can easily be consumed by fish and poultry animals; form saw dust and grass (fuel) pellet used in a pellet stove as fuel; produce iron ore pellets in varying diameters for blast furnace operation; and also produce pellets for chemical industry (Nwaokocha & Akinyemi, 2008).

This study focused on the performance evaluation of a fabricated cassava pelletizer of high production rate that can be used by villagers or subsistence farmers being the major producers especially in the place where there is instability of electricity or no electricity at all. Pellets are produced through the process called extrusion. A pelletizer consist of a screw pump similar to a screw press or screw conveyor in which feed is compressed and worked to form a semi-solid mass (Jean, 2003). The feed is forced through a restricted opening called the die at the discharge end of the screw. According to Harper (1981), the factors that most influence the nature of the pelletized product are:

a) The operating condition of the machine such as the temperature, pressure, diameter of the die aperture and the share rate.
b) The rheological properties of the food such as moisture content, the physical state of
c) The materials and their chemical composition, particularly the amount and type of starches, protein and fats contain therein.
d) Leakage flow, which is similar to pressure flow and is driven by a pressure gradient.
e) This flow occurs in the clearance between the screw flights and the barrel and within any slot in the barrel wall or surfaces. Leakage flow reduces the machine output.

According to Janssen (1978), the rate of flow is dependent on the die pressure, material viscosity and screw geometry. Reduction of moisture content causes the pressure in the barrel to go up (Michael, 1984). This usually does not result in a reduction of output because the viscosity of the material also goes up, offsetting the rise in pressure. Smaller die holes give greater resistance to flow through the die plate (Wiedmann and Strecker, 1987). Greater resistance causes higher die pressure and reduction of throughput. Cooling on the barrel improves the friction between the barrel wall and the materials (Khurmi& Gupta, 2006; Slater, 1984).

The first important factor in the pelletizing operation is the stable, consistent introduction of feed stocks into the machine. Inconsistent flow rates of feeds will more often than not produce inconsistent flow of products that will result in poor shape (Huber, 1990). According to Slater (1984), the required degree of accuracy of the feeders does depend on the tolerance of the extrusion process. Raw materials can greatly influence the design of feeders. The volume of material that screws can convey and the power they can transfer in pumping and heat generation is a design optimization which is made to suit different products (Wiedmann and Strecker, 1989). The conveying volume of a screw is a function of the screw speed, diameter and distance between flights of the screw (Rosen and Miller, 1973; Ryder, 1977).

Huber (1988) observed that the screw speed directly affects the degree of bared fill and hence the residence time distribution and the share stress in the material being pelletized. The screw speed is a factor in determining the maximum volumetric output of the pelletizer.

MATERIALS AND METHODS

The general consideration in designing this cassava pelletizing machine (Figure 1) is to produce a machine that can be easily assembled or disassembled, a machine in which the hopper allows materials to pass through effectively with minimum wastage; the pelleting chamber is made of metal so as to increase its durability; the hopper is sloppy to allow pellets to slide downward and get discharged by gravity. The hopper is welded to a cylindrical base – the barrel. The barrel houses the auger (worm screw) which propels the feeds. The auger works in two parts – the first part feeds-in the material in granular form and the second part compresses the material into semi-solid plastic mass. The pelletized mass is forced out through the die. The feed material is conveyed and pressed by a screw inside a tube or barrel leading to a rise in temperature due to increase pressure in the barrel. High temperature of operation in the presence of water promotes gelatinization of starch component and stretching of expandable components. The expanded feed product is shaped by the openings in the die (Figure 2).

Figure 1: A Cassava Pelletizing Machine.

The main features of the machine are: hopper, extrusion barrel, screw auger, bearing housing, crankarm, compression plate, flat die, pulley, sprout (gravity chute) knife cutter and the supporting frame.

Figure 2: Pelletized feed.

Machine Parameters

The parameters used to evaluate the performance of the Pelleting machine are as follows:

- Pelleting Efficiency, Losses ,Throughput Capacity

Pelleting Efficiency,

$$\eta_p = \frac{\text{mass of output material}}{\text{mass of input material}} \times 100\% \qquad (1)$$

$$\text{Losses} = 1 - \eta_p$$

Throughput capacity = mass of cassava mash pelletized in kg/hr

$$= \frac{\text{average mass of input material}}{\text{average time taken to pelletize}} \qquad (2)$$

RESULTS

Testing is a vital step in the process of machine development. After the design and construction, testing is necessary in order to:

Determine the performance of the machine,

Expose defect and area of possible improvement,

and Appreciate the level of success in the research.

Thus, it is important to test run a machine to determine its work ability and efficiency.

A known quantity of cassava mash was bought; this cassava mash was poured into the hopper of the machine with some ingredients like soya bean. Due to gravitational action the feed goes into the barrel chamber unit. The motor moves and rotates the auger shaft in the cylindrical barrel which is the extrusion chamber and the extruded pelletized cassava are collected through an outlet die after being cut with a cutter.

Factors that determine the quantity and the quality of the extrude rates are the feeding rate and the amount of moisture content.

Testing Using Conditioned Cassava Mash

The material used was gotten from a local source farmer and weighed in laboratory. Table 1 gives the quantities of the raw materials processed for the testing. Table 2 explains the Cassava pelleting machine test results using cassava mash.

Average mass of the cassava before pelleting = 1.5 kg

Average mass of the cassava after pelleting = 1.34 kg

Average time taken = 0.0778 hr

Pelleting Efficiency, $\eta_p = 89.33\%$

Losses = $10.67\ \%$

Throughput capacity (T_p) = kg/hr.

From Eqn (1) and (2) the required mass of input material and the expected mass of output material can be modelled as shown in Eqn (3) and (4) respectively:

(3)

(4)

where M_{in} and M_{out} are the masses of input (raw) material before pelleting and output material after pelleting respectively. And T_p and t_p are the throughput capacity and pelleting time respectively.

Table 1: Quantities of the raw material

Types of raw materials and	Quantities
a [illegible]	[illegible]
a [illegible]	[illegible]
a [illegible] $_1$ (kg)	[illegible]
a [illegible] been pressed, m_2 (kg)	[illegible]

Table 2: Testing result

Trial	Mass of cassava mash before pelleting (kg)	Mass of cassava after pelleting (kg)	Time taken (hr)	Product outcome
1	1.5	1.25	0.0692	Very good
2	1.5	1.44	0.0863	Good
3	1.5	1.32	0.0778	Very good
Average	1.5	1.34	0.0778	

DISCUSSION AND CONCLUSION

Pelleting machine was designed, fabricated and evaluated. It was fabricated using locally available materials and this makes the pelleting machine to be quite affordable. The operation of the machine does not require any highly technical expertise. The machine showed higher throughput capacity of 19.28 kg/hr with a maximum pelletizing efficiency of 89.33%., which is similar to the results of Nwaokocha and Akinyemi (2008). Equations (3) and (4) show that the required mass of input (raw) material for an expected output mass can be determinedgiving the information of the throughput of the machine and the machine efficiency for the pelleting machine. Results show that the grinding time determines the mass of cassava after pelleting viv-a-vis losses in the mass of cassava. The average percentage loss for the pelleting machine is given by 10.67%. Experimental results also show that the percentage losses decreases as grinding time increases, and as expected the efficiency will improve tremendously by reducing losses in the process. The grinding time is however a function of the feeding rate, the speed of the machine and the pelleting (grinding) effectiveness.Factors that determine the quantity and the quality of the extrude rates are the feeding rate and the amount of moisture content. Output results increases with the absence of disturbance and regular feeding.

Adopting the pelleting machine by small and medium scale farmers would help them in producing their own feed with local contents thereby alleviating the problems associated with the sourcing of imported feeds.

ACKNOWLEDGEMENT

The Authors expresses their gratitude to the technical staffs of the College of Engineering & Environmental Studies, Ibogun Campus, OlabisiOnabanjo University, Ago-Iwoyefor fabricating and assisting in testing the machine.

REFERENCES

Alonge A. F., Ekanem S. S. &Ituen E. U. (2012). Development of A Cassava Pelleting Machine. Journal of Agricultural Engineering and Technology, 20(2),: 29 – 37.

FDF (1995). Federal Department of Fisheries, Nigeria.

Harper J. M. (1981). Extrusion of Foods. Volume I and II Bola Raton, CRC Press, Florida (1st ed.).

Harper J. M. (1978). Extrusion Processing of Food. Food Technology, 32(7): 67-72.

Huber G. R. (1988). Pre-Conditioning. AACC Extrusion. A Short Course. San Antonio, Texas. May.

Huber G. R. (1990). Pre-Conditioning and Related

Extrusion Processing Issues. Presented at American Association of Cereal Chemists. Extrusion Short Course. February 19-21.

Janssen, L. P. B. (1978). Twin screw extrusion. New York Elsevier Applied Science 2nd edition

Jean C. C. (2003). Nutritional effects of extrusion cooking. Food Chemsitry, 20(4),: 263 – 283.

Khurmi R. S. and Gupta J. K. (2006). A Textbook of Machine Designing. Eurasia Publishing House (PVT) Ltd Ram Nagar New Delhi pp: 224-260

Michael W. (1984). Extrusion dies-design and Engineering Computation. Hamser Publications, Munich.

Nwaokocha C. N. &Akinyemi O. O. (2008). Development of a Dual-Mode Laboratory-Sized Pelletizing Machine.Leonardo Journal of Sciences, 13,: 22-29.

Ojomo A. O., Agbetoye L. A. S. &Ologunagba F. O.(2010). Performance Evaluation of a Fish Feed Pelletizing Machine.ARPN Journal of Engineering and Applied Sciences, 5(9): 88-97.

Rosen J. L. and Miller R. C. (1973). Food Extrusion. Food Technology. 27(8),: 46-53.

Ryder, G. A., (1977) Strength of Materials, The Macmillan Press Ltd., London.

Schultz K. (1990). Pelleting in Practice. Advances in Feed Technology No 1, Spring 1990. Verlag Moritz Schfer, Detmold, F.R.G. pp. 6-33.

Slater G. (1984). Application of extrusion to the production of breakfast cereals. Food Trade Review, pp. 127-128, 131-132.

Wiedman W. and Strecker J. (1987). How to automate an extruder. Food Engineering Int.

AGE AT MENARCHE AND MENSTRUAL PATTERN OF VAT TEXTILE DYE-EXPOSED WORKERS AT ITOKU, ABEOKUTA, SOUTHWEST, NIGERIA

[1]Soyinka, Oluwatosin Omobola; [1]Ogundahunsi, Omobola Abioye; [2]Oritogun, Kolawole Sunday; [2]Daniel, Olusoji James; [3]Olorundami, Babatunde Olorunyomi.

[1]Department of Chemical Pathology and Immunology, Olabisi Onabanjo University, Sagamu Campus.
Department of Community Medicine, Olabisi Onabanjo University, Sagamu Campus
[3]General Hospital, Iperu, Ogun State.
Corresponding author's e-mail address: tosinsoyinka@yahoo.com

ABSTRACT

Some changes in menstrual cycle characteristics have been associated with certain chemicals and/or occupational exposures. This study was conducted to investigate the likely effects of vat textile dyes on age at menarche and menstrual pattern of female subjects who are occupationally exposed to vat textile dyes. It involved a cohort of 39 female dye workers (aged, 16-49 years; minimum duration of exposure of two years) and 58 female unexposed subjects (aged, 17-48 years). Using a semi structured questionnaire, the menstrual history, cycle length, number of days of bleeding and degree of menstrual flow were obtained. Differences between the exposed and the control were tested for statistical significance using t-test for continuous variables and Chi-Square for categorical variables at P- value ≤ 0.05 level of significance.The mean age at menarche of the exposed (15.27±1.85 years) was not significantly different (p>0.05) from that of the control (12.83 ±4.50 years). The mean cycle length and number of days of bleeding were comparable to those of the unexposed (p>0.05). Among the exposed, 15.4% had irregular menstrual cycle which was not significantly different (p>0.05)from that of the control (10.9%). No premenstrual symptoms were recorded among the exposed population.It appeared that occupational exposure to vat dyes had no significant effects on age at menache, cycle length, number of days of bleeding, degree of menstrual flow and regularity of menstrual cycle of vat dye workers in Abeokuta.

Key words: Textile-dye workers, Menstrual Cycle, Age at Menarche, Pre- menstrual syndrome, Occupational Exposure.

Accepted Date: 29 June 2017

INTRODUCTION

"All chemicals are poisons, there is none that is not a poison but the dose makes the difference" Paracelcius (1493-1541). It is therefore important to test every chemical produced or in use for adverse effects. From epidemiological studies, documented effects of chemicals include reproductive disorders such as alterations in age at menache, menstrual pattern and hormone disbalance (Reutman *et al.,* 2002, Farr *et al.,* 2004,Park *et al.,* 2010, Hassani *et al.,* 2014).

Occupational exposure to chemicals and or occupational settings provides opportunities for testing of adverse effects of chemical exposure. This is because it involves a large quantum of exposures. This can be studied and then extrapolated to the public (Gardiner, *et al.,* 1982; Schrag and Dixon, 1985).

Dyes are coloured organic complex chemical compounds which have the ability of imparting colour on other substances; they have a long history and constitute an important component in our daily lives, they are either natural or synthetic (Bafana *et al.,* 2011; Kant, 2012; Ashfaq and Khatoon, 2014). Diverse categories of dyes include vat dyes, azo dyes, sulphur dyes, disperse dyes (Liaqat, 2009).

Human exposure to dyes occurs during manufacture, transportation, sale or application of dyes (Gardiner *et al.,* 1982; Rachootin, *et al.,* 1983,