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EVALUATION OF A PEDAL – OPERATED CASSAVA GRATER

Jekayinfa, S.O., Olafimihan, E.O. and Odewole, G.A.

Department of Mechanical Engineering, Ladoke Akintola University of Technology, P.M.B 4000, Ogbomoso, Oyo State.

ABSTRACT

A pedal – operated cassava grating machine was developed and evaluated. The grater is to bridge the gap between the motorized grater and the labour-intensive, traditional cassava grating device, and to ameliorate the tedium of cassava grating at the village level. The grater's component parts are: the grating unit, power and transmission unit, the housing, the hopper and the discharge chute. The cassava grater output capacity ranged between 28.50kg/h and 45.00kg/h depending on cassava variety. The particle size distributions in the end product representing medium fine, fine and powdery materials is 1:3:6. The grater capacity has a comparative advantage ratio of more than 220% over traditional grating device. One average person of between 25 –45 years of age can comfortably operate the grater continuously for about 16 minutes to produce an output of about 4kg.

Keywords: Cassava, Pedal – operated grater, Traditional grating device, Performance evaluation

INTRODUCTION

Cassava (Manihot esculenta crantz) is an important staple food crop in the tropical world. It is being grown majorly in West Africa, Nigeria being one of the highest producers. The perishable nature of cassava tubers poses a serious problem to storage. Cassava tubers once detached from the growing plant will not normally keep for more than a few days (40 – 48 hours), before deterioration sets in. The deterioration is caused by microbial infections and physiological factors like loss of moisture (Jonise et al; 1992). There is therefore an ever-increasing need to quickly process tubers in some stable forms as soon as it is harvested. Processing is also necessary to eliminate or reduce the poisonous cyanide contained in raw cassava and to improve palatability of the food products. Processing of cassava into gari (a granular food product) and cassava flour requires grating after the initial peeling and washing.

In the traditional method of cassava grating, a metal sheet (aluminium or galvanized iron) with punched holes that render one surface rough and the other smooth is used as the grater. The rough surface is pressed on the tuber, while the tuber is moved along the roughened surface. The resulting pulp passes through the holes into a container under. According to Igbeka et al (1992), this operation of manual grating of cassava is one of the most difficult manual operations in the traditional gari processing. They reported cases of operators' fingers being chipped off by the sharp rough surface. The traditional method of cassava grating is also labour – intensive and very slow. Jekayinfa (1995) reported that one man – day of labour produces about 150kg of peeled cassava. He also reported that back pain develops with time due to continual bending of the backbone. The traditional method of grating does not lend itself to uniform quality products. It has been reported that quality differed from one operator to the other and even with the same operator, quality was different from one batch to the other (Igbeka et al; 1992). It is difficult to increase productivity of cassava processing with the traditional method since grating operation alone will create a bottleneck. All these drawbacks have encouraged the need for mechanization of the grating operation. Despite the fact that mass production of cassava is being done in the rural areas, the people there face problems in the use of motorized graters due to difficulties in getting fuel. There is lack of electricity facility in most rural areas. As a result of these, many farmers prefer to transport their cassava tubers from the rural areas to the urban areas. The additional cost of transportation increases the cost of production.

Few authors (Igbeka et al; 1992; Jekayinfa, 1995; Odigboh, 1992, 1996, 1997, 1999; Jonise et al; 1992) have reported that for mechanization of agriculture in Nigeria to succeed, it must be based on indigenous designs, development and manufacture of most of the needed machines and equipment, to ensure their suitability to the crops as well as to the farmers' technical and financial capabilities. In line with this

this work evaluates the performance of a pedal – operated cassava grater earlier developed in Department of Mechanical Engineering, Ladoke Akintola University, Ogbomoso.

MATERIALS AND METHODS

Materials

A pedal operated cassava grater (Fig. 1) was developed. It comprises the grating unit, power and transmission unit, the housing, the hopper and the discharge spout. The components of the grater with specifications are as follow:

1. **Hopper**: It was constructed using 24 gauge galvanized iron sheet. The hopper is in form of a rectangular based pyramid with top length of 450mm, bottom length of 210mm and height of 400mm. The edge of the top is reinforced with a 25mm x 25mm angular bar
2. **Grating Plate**: A squared edge of a galvanized sheet measuring 300mm x 625mm is cut out and punched at 1 cm interval with a 125mm long nail. This is wrapped around the grater drum (made of wood) and secured with screw, with the roughened surface of the sheet exposed.
3. **Power Generation and Transmission Unit:** The power needed by the machine is generated manually and transferred by mean of a chain attached to the sprocket of a free wheel. The chain has 44 teeth for the driving sprocket and 22 teeth for the driven (free wheel). The chain length is 1186mm. The power to operate is supplied by man and its transmission is by a free wheel sprocket that operates in a similar fashion to a standard bicycle.

Methodology

The machine was operated and the following performance features were noted:

1. Capacity
2. Power and labour requirement
3. Quality of grated pulp
4. Grating Efficiency

To carry out the evaluation, 5 sets of peeled cassava (Odongbo type) tubers each of mass about 12kg representing 5 different ages of tuber maturity, spring balance, stop watch and polythene bags of negligible weight were used. Two operators were involved in the grating experiment. One person mounted the equipment and cycled while the second person fed in the tubers manually. The pedaling had commenced before tube feeding to avoid clogging and it was made continuous as long as the tuber was fed. The spring balance was used to weigh the sets of peeled cassava. The time taken for a complete grating was recorded. The weight of the pulp was then read and recorded.

The capacity of the grater was assessed in terms of the machine output (kg/h). The product quality assessment was based on the uniformity of size of the grated cassava. This was done by sieving the grated and dewatered cassava (cassava cake). Three sizes of sieves were used to relate the sizes of the grated cassava to its food value either as 'Lafun', 'Gari', Starch or some other applications. Sizes greater than 2.36mm were considered rejects. Mesh No 200 was considered as the pan and materials retained here were classified as very fine or powder.

The power requirement of grating operation using the pedal – operated grated was evaluated to ensure that the would be operators are not subjected to un-anticipated stress which may result in loss of efficiency, lower productivity and any form of future disability. This aspect of evaluation was carried out by the use of a procedure employed by previous researchers (Igbeka, 1993; Nwuba, 1999; Aremu and Olorunnisola, 1998). The procedure involves the use of heart rate index in which the resting and post – task heart rates of each subject were measured using a stethoscope, while the energy expenditure rates (ERR) were obtained using equation 1 developed by Nwuba and Kaul (1987).

$$ERR = \frac{HR - 66.0(KJ/\min)}{2.4} \qquad (1)$$

Where HR = heart beats per minute

RESULTS AND DISCUSSION

The Grater Capacity

The grater capacity is the amount of grated pulp that could be produced per unit time. The test results of the developed pedal – operated grater along with the traditional grating device are summarized in Table 1. The pedal operated grater had the higher average grating capacity of 42.65kg/h with over 220% advantage ratio over traditional device. The test grater has a capacity of 28.5kg/h to 45.00kg/h. The variation depends on feeding rate, the size and age of the tuber and the gender operator. Summarized grater's output results on gender basis is shown in Table 2.

Production Quality

The result of sieving analysis presented in Table 3 shows that the particle size distribution is 1:3:6 (proportion of medium fine, fine and powdery materials). Medium fine materials are good for 'Lafun', fine materials are good for 'Gari' while very fine (powdery) materials are good for starch, flour and 'Gari'. These results compare favourably with the report of Jonise et al (1992).

Energy Expenditure for Grating

Table 4 presents the energy expenditure rate (kJ min) of the eight individual subjects in cassava grating together with their specific energy expenditures (energy expenditure per kilogram of grated cassava). A comparison of the energy expended in grating using the pedal – operated grater and the traditional device shows that the pedal operated grater consumed more energy (about 25% higher) than the traditional device. A comparison of the results in Table 3 with Zander's classification of physical load (Zander, 1990) shows that pedaling operation by the male and female subjects, while grating cassava tubers, produced light load in the individual operators. This is an indication that the use of the test grater is ergonomically advantageous.

Effect of Operator's Gender on the Grater's Output.

Despite the minimal age difference between the male and female subjects employed for grating exercise, there are notable differences in their heights, weights and body dimensions. This agrees with similar outcomes reported by Poschen (1993) and, Aremu and Olorunnisola (1998). Results of comparative grating test carried out by the subjects using the traditional grating device and the test grater are presented in Table 4. The average grating output of all the subjects was greater using the test grater (36.81kg h) than with the traditional device (12.36kg h). The outputs of the 4 male subjects were generally greater than those of the 4 female subjects. This was largely due to the smaller muscle sizes of the female subjects. The smaller muscle size of women compared to men reduces their work capacity, sometimes by as much as two thirds that of their men counterparts (Poschen, 1993).

CONCLUSIONS

The following conclusions can be drawn from the study

1. The pedal – operated cassava grater capacity ranged between 28.30kg/h and 45.00kg/h, the higher capacity was obtained from a male operator while the lower value was from a female operator. This is about 220% above capacity of the traditional grating device.
2. Labour requirement for operating the machine was evaluated to be light irrespective of the gender of the operators.
3. The test pedal operated cassava grater is found to be appropriate for village level cassava grating operation.

Table 1: Capacity Rating (kg/h) of the Test Cassava Grater and Traditional Grating Device Using men as Operators

Test Number	Tuber Input per Grating Operation (kg)	Grating Time (min) PG	Grating Time (min) TR	Output Rate (kg h) PG	Output Rate (kg h) TR
1	12.00	16	47	45.00	15.20
2	12.00	17	49	42.50	14.60
3	12.00	18	48	40.15	15.00
4	12.00	16	45	45.00	16.00
5	12.00	17	46	42.55	15.50
Average	12.00	16.8	47	43	15.30

PG – Pedal Operated Grater TR Traditional Grating Device

Table 2: Grating Output on Gender Basis

Subject code	Gender	Grating Output kg hr Pedal – Operated Grater	Grating Output kg hr Traditional Grating Device
M_1	Male	45.00	14.55
M_2	Male	42.50	15.00
M_3	Male	40.15	14.60
M_4	Male	45.00	16.00
Average (Male)		43.16	15.04
F_1	Female	30.20	10.65
F_2	Female	30.51	8.75
F_3	Female	29.68	9.60
F_4	Female	28.50	9.50
Average (Female)		29.72	9.63

Table 3: Proportion of Materials Representing Given Range of Particle Sizes.

Mesh No	Size of Opening	Percent Material Retained	Size Classification	Possible Food Value
8	2.36	10.2	Medium Fine	'Lafun'
14	1.40	32.5	Fine	'Gari'
200	0.075	57.3	Very Fine and Powdery	Starch, Flour and 'Gari'

Table 4: Energy Expenditure Rate (EER) (kJ/min) and the Specific Energy Expenditure SEE (kJ/kg) of the Eight Subjects While Operating Both the Pedal – Operated Grater and Traditional Grating Device.

Subject code	Gender	Pedal – Operated Grater EER	Pedal – Operated Grater SEE	Traditional Grating Device EER	Traditional Grating Device SEE
M_1	Male	13.05	17.40	10.15	41.86
M_2	Male	12.15	16.72	9.75	37.38
M_3	Male	12.25	16.52	9.15	27.60
M_4	Male	11.95	16.83	8.95	34.62
F_1	Female	8.60	17.09	7.10	40.00
F_2	Female	8.75	17.21	7.25	49.71
F_3	Female	8.88	17.95	6.95	43.44
F_4	Female	9.05	19.05	7.15	45.16

Fig: The Pedal-Operated Cassava Grater.

REFERENCES

Aremu, A.K. and A.O. Olorunisola, (1998). Ergonomic Evaluation of a Maize Sheller. Proceedings of Nigerian Institute of Industrial Engineers Productivity Conference. 1:162 – 168.

Igbeka, J.C.; Jony, M. and D. Griffon (1992). Selective Mechanization for Cassava Process. Journal of Agricultural Mechanization in Asia, Africa and Latin America, 23(1): 45 – 50.

Igbeka, J.C. (1993). Some Ergonomic Studies of Nigerian Women Involved in Agricultural Processing. Proc. XXV CIOSTA – CIGR Congress, Wageningen, Neither Lands, Pp 183 – 189.

Jekayinfa, S.O. (1995). Some Engineering Aspects of Cyanide Removal in Cassava Processing. M.Sc. Seminar Report. Department of Agricultural Engineering, University of Ibadan.

Joinse, A.Y., Eleseku, E.M., Oladoja, A.I. and R.C. Nzeocha (1992). Fabrication and Evaluation of IITA – Developed Cassava Grater and Chipper for Introduction in Obiti Village, Imo State. Training Output, In – Country Training – Workshop on Design, Operation and Maintenance of IITA Developed Crop Post Harvest Technologies, IITA Ibadan, Nigeria 27 Jan. To 1 Feb., 1992. Pp 25 – 40.

Nwuba, E.I.U. and Kaul, R.N. (1987) Engineering Requirements of Hand Tools for Wood Cutting. Journal of Agricultural Engineering Research, 36: 207 – 215.

Odigboh, E.U. (1992). Research, Development and Manufacture of Agricultural Machinery in Nigeria: A National Imperative. NSE 1992 Distinguished Food and Agriculture Lecture. Co-sponsored by National Centre for Agricultural Mechanization (NCAM). NCAM, Ilorin, II July, 1992.

Odigboh, E.U. (1996). Small – Medium – Scale Farmer Oriented Mechanization: A Choice Strategy for Energizing Nigerian Agriculture. Lead Paper presented at 1995 NSAE Annual Conference on "Engineering in a Sustainable Agriculture in Nigeria". Federal University of Technology, Akure (FUTA). April 25 – 28. NSAE 95 Conference Proceedings Pp 96 – 115.

Odigboh, E.U. (1997). Confronting the Challenges of Agricultural Mechanization in Nigeria in the Next Decade: Some Notes, Some Options. Keynote Address Presented at the Nigerian Society of Agricultural Engineers (NSAE)'s Annual Conference NSAE Conference Proceedings Pp. 7 – 16.

Odigboh, E.U. (1999a). Engineering Design for Strategic Supply of Appropriate Farm/Rural Machines/Equipment for Enhanced Agricultural Development in Nigeria. Paper Presented at First National Engineering Design Conference, Organized by NEDDC of NASENI, COREN and NSE, Abuja, Sheraton Hotels and Towers, September 26 – 29.

Odigboh, E.U. (1999b). Agricultural Mechanization: Where Nigeria is Now and Where It Ought to be in the Next Century. Proceedings of COREN 9th Engineering Assembly 4th – 5th November, 1999. Pp 29 – 45.

Poschen, P. (1993). Forestry, A Safe and Healthy Profession: UNASYLVA: International Journal of Forestry and Forest Industries, 44 (172): 43 – 49.

Zander, J. (1990). Principles of Ergonomics 6th Edition. Agricultural University, Wageningen, NetherLands.