COMPARATIVE PERFORMANCE EVALUATION OF INTERMEDIATE GINGER PULVERIZING MACHINE WITH TRADITIONAL PROCESSING TECHNIQUE IN NIGERIA

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ABSTRACT

The intermediate ginger pulverizing machine and the traditional ginger processing technique were studied and compared. The performance of the two mills was conducted and evaluated in terms of throughput, energy coefficient, pulverizing efficiency, reduction ratio, particle size distribution and losses. The test result revealed that the intermediate ginger pulverizing machine had higher values of throughput, 96kg/hr; energy coefficient 0.032 ton/hp-hr; pulverizing efficiency 80%; particle size distribution 1.18mm to 10.00mm; reduction ratio 21:1 compared to the traditional mill with 18kg/hr, as throughput and 60% efficiency.

Key words: Pulverizer, Performance, Ginger; evaluation, Technology

INTRODUCTION

Ginger (*zingiber offinale*) belongs to the plant of zingiber raceae. It is an underground tuberous stem or rhizomes characterized by its strong essence [5].

There are two major varieties cultivated in Nigeria, which are the yellow and black varieties. The term 'yellow' and 'black' are misnomers. The chemistry of ginger makes it useful in the food and beverage industry in the form of spices, extractives (oleoresin and essential oil), juice, peppermint, biscuits, beer, bread, wines, etc. It is widely used in the pharmaceutical industry for production of drugs because of its biological active ingredients such as gingerols, zingerberene, shogaols, zingerone, etc. These components act as herbal remedies in the body by:

- Boosting the immune system
- Warming the body and liberating stagnant body fluids.
- Reducing high blood pressure.
- Reducing cholesterol
- Ensuring easy and regular menstrual flow
- Digestion and absorption of food in the body[4].

Pulverization (size reduction) is a major challenge in ginger processing. It is a limiting unit operational step to realizing any value added product from ginger. The value of size reduction phenomena comes from:

- Aiding the extraction of constituent from the composite structure such as ginger.

- Improving mixing/blending.
- Satisfying consumer or functional requirement.
- Increasing the ratio of surface area to volume so as to: Reduce drying time, increase extraction rate, decrease heating, cooking time etc.

A small number of commercial ginger pulverizers are active in Nigeria. These commercial pulverizers have a high base cost, capacity, maintenance cost and require skill to operate. There is a gross under utilization of the existing commercial pulverizers due to low patronage by the local farmers [1].

The most wide spread method of ginger processing in the producing localities is the traditional technology. Traditionally, ginger is pulverized by pounding with pestle and mortar and sometimes along with grinding slowly between stones. This method of processing is unproductive, unhygienic, laborious, space and time consuming and often result in great loss of the ginger rhizomes.

It is a common view that the intermediate processing technologies, if introduced in the local rural communities, would improve the economy and productivity of the rural fold. The concept of intermediate technology was presented by Schumacher [8]; Ndirika and Bugs [6] as an alternative course for development of poor people, which enable them to work themselves out of poverty. They described it simply as a "middle way" between traditional and modern technology. It is therefore obvious that the concept of intermediate technology will enable rural people to become more productive in their activities, self sufficient, sustain income generation and create surpluses, which can be revolved in their families, business and communities. In the view of this, an intermediate technology ginger pulverized have been developed [1] whose performance is evaluated and compared to traditional techniques of ginger pulverizing.

The target community for the traditional method of ginger pulverizing is Kafanchan, a sub-urban community in Southern Kaduna, Kaduna State in the north-central geo-political zone of Nigeria. This community is notable for ginger production, which is a major foreign exchange earner in Nigeria.

MATERIALS AND METHODS

The intermediate technology ginger pulverizer and traditional techniques were used for ginger pulverizing during the performance evaluation. The descriptions and specifications of this technology (intermediate) and traditional are presented in tables 1 and 2.

The variety of ginger used during the performance evaluation was (yellow ginger). The moisture content of the ginger was 75.32%, which is considered as average post-harvest moisture content[3]. Experiments were conducted on the intermediate technology ginger pulverizer designed and fabricated by B.O. Aderemi [1] and the traditional processing technique for ginger pulverizing. The following parameters were measured and evaluated as recommended by Perry *et al*[7]

Reduction ratio, $X_R = \frac{X_F}{X_P}$ 1

Throughput capacity, $C_T(kg/hr) = \frac{Q_R}{t}$ 2

Pulverizing efficiency ŋ (%) = $\frac{Q_T}{Q_O} * 100$ 3

Losses, (L_R, %) = $\frac{(Q_T - Q_O)}{Q_T} * 100$ 4

Where
X_F= Particle size of feed, mm
X_P=Particle size of product, mm
Q_o=Quantity of ginger in feed, kg
Q_T= Quantity of pulverized ginger, kg
t = Time, hr

Instrumentation and Measurement

A top weighing balance and metler balance with 0.001g precision were used for weight measurements. A Nokia 7210 stop watch was used for all time measurements. The moisture content of the rhizome was determined by oven dry method at a temperature of 130^{o}C for 19 hours [2] the particle size was measured using U.S sieves.

Data Analysis

The data from the experimental evaluation of the intermediate technology ginger pulverizer and the traditional technique were analyzed using excel statistical packages. Descriptive statistical tools such as tables and bar chart as recommended by Trochim (1999) were used to describe the basic features of the data in the study.

RESULTS AND DISCUSSION

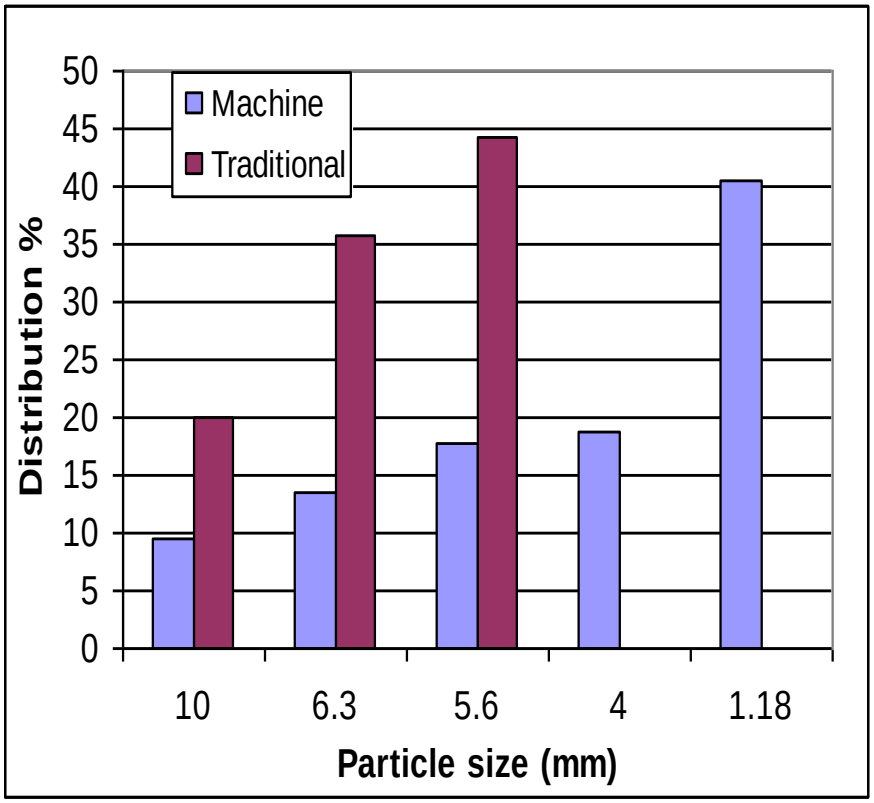

Fig. 1: Particle Size Distribution of Traditional and Machine Ginger Pulverizing

Throughput and Pulverizing Operations

Table 3 shows that the throughput of the intermediate machine was 96.0kg/hr while the local mill was 18.0kg/hr indicating a mark difference of 43% improvement between the intermediate over the local mill. The local mill pulverizes by pounding with pestle and mortar, which is energy sapping, time consuming, with low output (18kg/hr) and unhygienic. Each intermediate mill is equivalent to a minimum of five local mills, so there is an energy saving of fivefold with the intermediate ginger pulverizing machine. The work index (energy coefficient) was 0.032 ton/hp-hr corresponding to that of ball mill (0.02 to 0.1 ton/hp-hr) of hard materials[7]. There were high losses, 40% from the traditional mill during operations as a result of spillage in pounding.

Particle Size Distribution and Reduction Ratio

Tables 4 and 5 show the particle size distribution and reduction ratios of the intermediate and the local ginger pulverizing mills respectively. The peak size 1.18mm from the intermediate mill occurred at 40.85% distribution this size is suitable for extraction of water-soluble and other extracts from ginger; while the peak size traditional mill, 5.60mm occurred at 44.33% distribution. This shows that the minimum particle size obtained from the local mill (see fig 3.0 and tables 4 and 5), 5.60mm is far larger than that obtained from the intermediate mill (1.18mm) by reduction ratio of 4.75:1.

Over 80% of 60 µm particle size has been reported from ultra-fine modern mills [7] from table 3, the maximum ratio for the intermediate and local ginger pulverizing mills were 21:1 and 4.3:1 respectively.

CONCLUSIONS

The following conclusion can be drawn from the results. The traditional techniques for pulverizing ginger results in poor quality (reduction ratio), low output, time wasting and drudgery. The intermediate technology for ginger pulverizing is appropriate in terms of improvement in quantity and quality of output, reduction of drudgery and time of operation.

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APPENDIX

Table 1: Description and specification of Intermediate technology ginger pulverizing machine

Parameter	Specification
Type of Motor	3 phase 50Hz
Capacity	2.2kW(3hp)
Speed of Drive	1430rpm
Speed of Rasper	1873rpm
Speed of Rotor	2860rpm
Ginger Variety	Yellow

Table 2: Description and specification of traditional ginger pulverizing mill

Parameter	Specification
Gender	Female
Method	Pestle and Mortar
Weight of Operator	68kg
Height of Operator	1.52m
Mass of Pestle and Mortar	35kg
Age of Operator	52 years

Table 3: Comparative performance on intermediate and local ginger pulverizing mills

Parameter	Intermediate	Local
Throughput, kg/hr	96.00	18.00
Pulverizing Efficiency, %	80.00	60.00
Energy Coefficient, ton kg/hp-hr	0.032	------
Reduction Ratio (max)	21:1	4.3:1
Losses, %	24.63	40.00

Table 4: Particle Size Analysis and Reduction Ratio of Intermediate Ginger Pulverizing Machine

S/No	Sieve size (mm)	Distribution, %	Reduction ratio
1	10.00	9.50	2.43:1
2	6.30	13.42	3.86:1
3	5.60	17.68	4.34:1
4	4.00	18.82	6.08:1
5	1.18	40.58	20.50:1

Table 5: Particle size distribution and reduction ratio of local ginger pulverizing mill

S/No	Sieve size (mm)	Distribution, %	Reduction ratio
1	10.00	20.00	2.43:1
2	6.30	35.67	3.86:1
3	5.60	44.33	4.34:1
4	4.00	- - - - -	- - - - -
5	1.18	- - - - -	- - - - -