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Research Article

EFFECT OF PROCESSING PEARL MILLET ON DIFFERENT PHYSICAL PARAMETERS

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ABSTRACT

An experiment was conducted to determine the effect of grinding pearl millet before and after heating on energy and time consumption in comparison to maize. Twenty liter of water was sprinkled uniformly over 100 kg of pearl millet grains and kept for 24 hrs. Soaked pearl millet grains were dry heated (225±25^{0}C for 45-60 seconds) in an iron pan containing salt as heat transfer medium. The particle size of maize and pearl millet grains was reduced by a country made hammer mill using 2 mm and 3 mm hole size screen. Electricity consumption and time taken for grinding were more (P<0.05) for maize as compared to pearl millet. Increasing the hammer mill screen hole size from 2 mm to 3 mm significantly decreased (P<0.05) the time and electricity consumption. With an increase in the sieve size, there was an increase in bulk density. Heating of pearl millet decreased the bulk density and significantly increased its particle size. Production rate (kg/h) of pearl millet was higher (P<0.05) and energy consumption was lower (P<0.05) as compared to maize.

Keywords: Pearl millet, heating, grinding, bulk density, energy consumption

Grinding is the most common method of feed processing. It reduces particle size for exposure of more surface area to action of digestive enzymes. Grinding of feed ingredients generally improves feed palatability, digestibility, and mixing properties. It also increases the bulk density of some ingredients and facilitates further processing such as extrusion and pelleting. Pearl millet has been demonstrated as an alternative feed ingredient for broiler chicken diets. Nearly all feed ingredients added in to broiler chickens are in whole, pellet or crumble forms (Dozier, 2001). Utility usage represents a significant proportion of the associated costs with feed manufacturing (Dozier, 2002). The grain of pearl millet is smaller than maize, which is likely to influence energy usage during grinding. The objective of this study was to assess the effect of grinding and heating pearl millet on energy usage, production rate and some physical parameters as compared to maize.

MATERIALS AND METHODS

Twenty liter of water was sprinkled uniformly over 100 kg of pearl millet grains and kept for 24 hrs. Soaked pearl millet grains were dry heated (225±25^{0}C for 45-60 seconds) in an iron pan using common salt as a heat transfer medium. The material was ground in a country made hammer mill having sieves of 2.5±0.14 kg weight and 47 × 35.5 × 0.3 cm (length × breadth × thickness) dimensions. The dimensions of hammers were 9.9 ± 0.7 × 2.38 ± 0.3 × 0.5 cm (length × breadth × thickness) with 1 cm hole on both ends and weighing 100±2.5g. Numbers of holes in 2 mm and 3 mm sieves were 2618 and 2326, respectively. The hammer mill was fitted with a cuboidal roller/rotor (28.8 cm shaft length) having provisions for fitting 96 hammers. Twenty four hammers (6 on each side adjusted alternately) were fitted in the roller. Time taken for grinding per quintal material was recorded by a digital stopwatch and electricity consumption was measured with a digital amp-volt meter. A row-tap sieve shaker was used to determine the particle size (Pfost, 1976). The sieves were arranged in ascending order with the largest number sieve at the bottom and the smallest number sieve at the top. Hundred gm of sample was placed on the top sieve and shaken until the weights of each sieve become constant (20 minutes). The bulk density was measured with the help of cubic foot box. The data was statistically analysed using a Complete Randomized Design (Snedecor and Cochran, 1994).

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RESULTS AND DISCUSSION

The data regarding time taken, production rate (kg/h), temperature change (^{0}C), electricity consumption, bulk density and particle size (μ) are presented in Table 1. Time taken (minutes/quintal) for grinding was more (P<0.05) for maize ground through 2 mm sieve followed by maize ground through 3 mm sieve and the least for raw pearl millet ground through 3 mm sieve. Heating of pearl millet grains significantly increased (P<0.05) time taken for grinding possibly due to increased surface area of grains. Berwal (2005) also reported similar observations. Production rate (kg/h) was more (P<0.05) for pearl millet than for maize. Heating of pearl millet decreased (P<0.05) the production rate. Dozier *et al.* (2005) also reported more production rate and less energy consumption for grinding of pearl millet as compared to grinding of maize. Production rate (kg/h) was the highest for raw pearl millet ground through 3 mm sieve (6451.61 kg/h) followed by heated pearl millet ground through 3 mm sieve (5607.47 kg/h) and the lowest for maize ground through 2 mm sieve (980.39 kg/h). Numerically higher values for change in temperature just after grinding were recorded in pearl millet as compared to maize. Reece *et al.* (1985) demonstrated a 37% increase in output from a hammer mill by increasing the hammer mill screen opening from 3.18 mm to 4.76 mm. The effect of screen hole size on electricity consumption was more prominent in case of maize grains as compared to pearl millet grains. Pearl millet grain is much smaller than maize. Therefore, a small amount of pearl millet grain was not grounded due to its small size. As a result, less friction might have occurred during the grinding, leading to reduced energy consumption. The percentage of whole grain found in the mash after grinding was approximately 10%.

Electricity consumption was the highest for maize ground through 2 mm sieve followed by 3 mm sieve and the least for raw pearl millet ground through 3 mm sieve. Significantly (P<0.05) lower electricity consumption was observed for pearl millet ground through 2 mm and 3 mm sieves with or without heating as compared to maize ground through 2 mm and 3 mm sieves. Feed ingredients ground through 3 mm sieve consumed less electricity for grinding as compared to 2 mm sieve. Heating increased the electricity consumption for pearl millet grain in both 2 mm and 3 mm sieves. As a result electricity cost was more for maize ground through 2 mm sieve followed by 3 mm sieve and the lowest for raw pearl millet ground through 3 mm sieve. Feed ingredients ground through 3 mm sieve resulted in less electricity cost for grinding as compared to 2 mm sieve. Heating of pearl millet increased the electricity cost for its grinding in case of both 2 mm and 3 mm sieves. The results indicate that with an increase in sieve hole size, electricity consumption decreases considerably. These observations are similar to that of Berwal (2005) who also reported that electricity consumption and cost decreased with the increase in sieve size. Bulk density (Kg/m3) was the highest for raw pearl millet ground through 3 mm sieve followed by raw pearl millet ground through 2 mm sieve and the lowest in heated pearl millet ground through 2 mm sieve.

Table 1
Effects of heating and grinding pearl millet grains on various physical parameters

Parameter	Maize (2 mm)	Maize (3 mm)	Raw pearl millet (2 mm)	Heated pearl millet (2 mm)	Raw pearl millet (3 mm)	Heated pearl millet (3 mm)
Time consumption (minutes/quintal)	6.12^{f}±0.02	3.37^{e}±0.52	1.47^{b}±0.01	2.24^{cd}±0.27	0.93^{a}±0.16	1.07^{a}±0.16
Production rate (kg/h)	980.39^{a}	1780.41^{b}	4081.63^{c}	2678.57^{d}	6451.61^{e}	5607.47^{f}
Temperature change (^{0}C)	2.8	2.5	3.5	3.6	3.0	3.2
Electricity consumption (KWh/ q)	0.90^{d}±0.02	0.50^{c}±0.10	0.20^{ab}±0.00	0.30^{b}±0.00	0.15^{ab}±0.05	0.20^{ab}±0.00
Electricity cost (Rs./q) @Rs.3.5/unit	3.15^{e}±0.07	1.75^{d}±0.35	0.70^{b}±0.00	1.05^{c}±0.00	0.52^{a}±0.18	0.70^{b}±0.00
Bulk density (Kg/m3)	957.02^{d}±0.57	985.28^{e}±0.59	1045.31^{f}±0.62	907.58^{b}±0.54	1137.13^{g}±0.67	974.68^{c}±0.58
Particle size (μ)	582±31	648±37	588±45	646±50	608±42	712±55

Values with different superscripts in a row differ significantly (P<0.05)

Significantly (P<0.05) higher bulk density was recorded for pearl millet ground through 2 mm and 3 mm sieves with or without heating as compared to maize ground through 2 mm and 3 mm sieves. Feed ingredients ground through 3 mm sieve had higher bulk density as compared to 2 mm sieve. Heating of pearl millet decreased bulk density probably due to increased surface area in heated pearl millet. The particle size of pearl millet ground through 2 mm and 3 mm hole size sieves was numerically bigger than that of maize ground through same sieves. It may be attributed to the partial grinding of the pearl millet and passing of whole grains through these sieves. The particle size of heated pearl millet was numerically bigger than unheated pearl millet, if ground through same sieve. It may be concluded that pearl millet grains had an increased grinding rate and required less energy for grinding as compared to maize.

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