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Effect of Grinding Time and Moisture on Size Reduction of *Makhana*

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A study was conducted on grinding behaviour of *makhana* (popped *Euryale ferox*) by keeping the duration of grinding (25–150 sec) and moisture content of *makhana* (0.5–14% w.b.) as independent variables and the mass fraction retained on B.S. sieve (+4, +14, +20 and –20 fractions) as dependent parameters. Mass fraction retained on each sieve increased with grinding time except +4 fraction, which actually declined. The –20 fraction decreased with increase in moisture content of *makhana* and a consequent increase in +14 fraction was observed. The +14 fraction was found to be maximum at 14% moisture content of *makhana* and 1 min grinding time beyond which it declined continuously.

Keywords : Gorgon nut (*Euryale ferox*), *Makhana*, Grinding, Particle size, *Makhana kheer*, Pudding.

Makhana is a popped kernel of gorgon nut (*Euryale ferox*), which is cultivated in stagnant fresh water pools of the north and north-eastern States of the country. Its wild populations are also available in China, Japan, the former Soviet Union and North America (Jha et al. 1991). Processing of gorgon nut to get *makhana* is mainly concentrated in Darbhanga, Madhubani, Saharsa, Samastipur, Muzaffarpur and adjoining districts of north Bihar.

Makhana contains (g/100 g) 12.8 moisture, 76.9 carbohydrates, 9.7 proteins, 0.1 fat, 0.5 total minerals, 0.02 calcium, 0.9 phosphorus and 0.001 iron (Gopalan et al. 1987). *Makhana* is used in various forms of foods. The most widely accepted item is *kheer*, a milk-based pudding. Conventionally *makhana kheer* is prepared by the traditional method, which involves roasting of *makhana* in an open cast iron pan followed by manual grinding (hand-pounding) to smaller size and cooking in boiling milk to get a desired consistency. In absence of any standard technique, the conventional method of making *makhana kheer* results in wide variations in consistency and other sensory quality attributes. The variation in the quality of product is mainly due to use of unspecified means of size reduction (usually by hand-pounding), resulting in uncontrolled size distribution of *makhana* particles. The objectives of this study were to evaluate the effect of moisture content and grinding time on particle size distribution of ground *makhana* and to suggest suitable grinding time and moisture content of *makhana* for getting maximum percentage of uniform particle size.

Makhana procured from local market, was sorted into three grades (Jha and Prasad 1996). The grade I *makhana* was used in the experiment. The moisture content of *makhana* was determined by hot air oven method (Hall 1970). Samples of *makhana* with three moisture levels viz., 14% (as purchased), 7% (partially dried) and 0.5% (almost completely dried) were prepared by drying raw *makhana* in hot air oven. The prepared samples were stored in different desiccators partly filled with saturated salt solutions so as to equilibrate and maintain its moisture at desired level. Studies on size reduction of samples prepared as above were conducted in a domestic mixer/grinder (Make-Sumeet, model sp-16), using blade recommended for dry grinding. A sample of 50 g *makhana* was put into the grinding bowl and lid was closed. The speed controlling knob was kept at medium level and ground for desired period (30–150 sec). The grinding time was recorded with the help of a stop watch. The loss of moisture, if any, during the grinding process was not controlled. The ground *makhana* was passed through a set of sieves (BS sieve numbers 4,14,20) and a pan at the bottom. Materials retained (mass fraction) at each sieve were expressed as percentage of initial weight of the sample. Experiments were replicated thrice to minimise experimental error and average data were analysed. Mass fractions retained on each sieve were plotted against the grinding time and initial moisture content of *makhana*. Mass fractions retained on sieve numbers 4,12,30 and on pan were denoted as large, medium, small and fine particles, respectively.

In general, mass fraction of material retained on each sieve, except the +4 fraction, increased with increase in grinding time at each moisture level of *makhana* (Fig. 1–3), whereas, the amount of *makhana*

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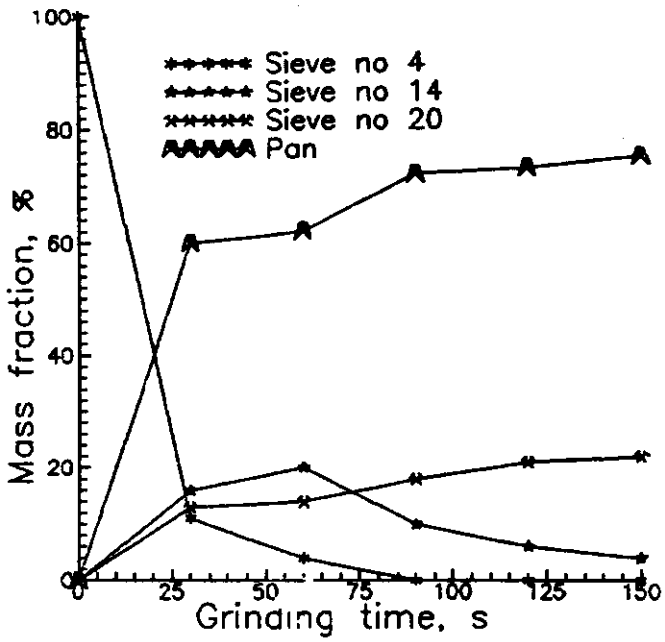

Fig. 1. Sieve analysis of grinding of *makhana* for various periods and moisture content at 0.5% (wb)

particles retained on sieve no. 4 (large size particles) decreased with increase in grinding time and being added to other particle sizes. This happens due to the fact that the size reduction of a batch of sample increases with increase in grinding time. Medium size particle, i.e. +14 fraction, increased with increase in grinding duration upto 60 sec and thereafter, particle size started decreasing. This may be due to decrease in amount of +4 fraction of material initially to medium size and subsequently getting further ground to smaller sizes.

The effect of moisture on mass fraction retention, illustrated in Fig. 4, indicated that moisture had practically no effect on +14 and +20

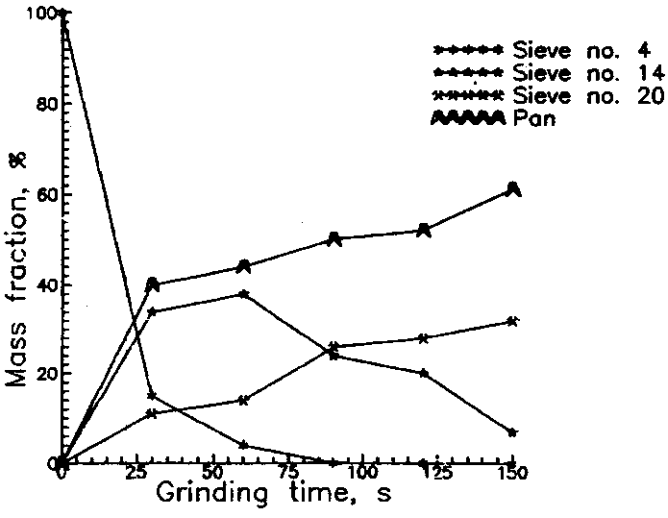

Fig. 2. Sieve analysis of grinding of *makhana* for various periods and moisture content at 7% (wb)

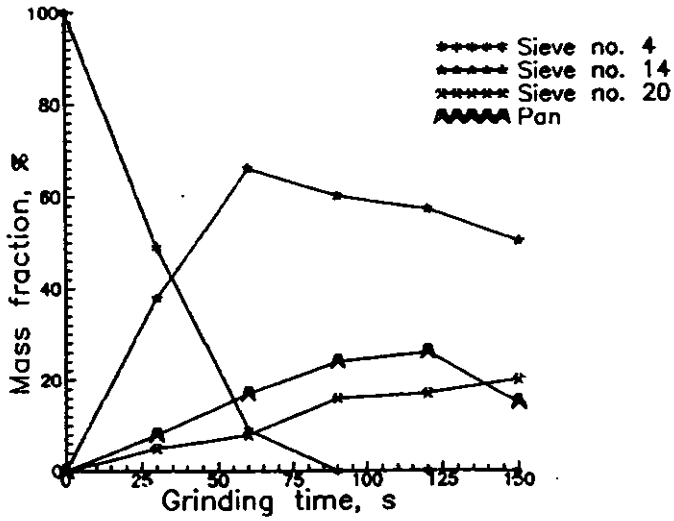

Fig. 3. Sieve analysis of grinding of *makhana* for various periods and moisture content at 14% (wb)

fractions upto a moisture content of 7%. Beyond this moisture evel, however, the +14 fraction increased, whereas +20 fraction decreased. Materials retained on pan (–20 fraction) and on sieve number 14 (+14 fraction), respectively decreased and increased almost linearly with moisture content for 1 min of grinding time (Fig. 4). Decrease in –20 fraction (fine particles), which consequently produces more medium size particles with increased in moisture, is due to the fact that *makhana* contains higher amount of starch i.e., 77%, (Jha and Prasad 1993), which gets gelatinised during popping operation of gorgon nut (Jha 1993). The gelatinised starch in popped *makhana* gets softened, resulting in reduction in its brittleness.

The study has revealed that the percentage of medium sized particles becomes maximum (66%)

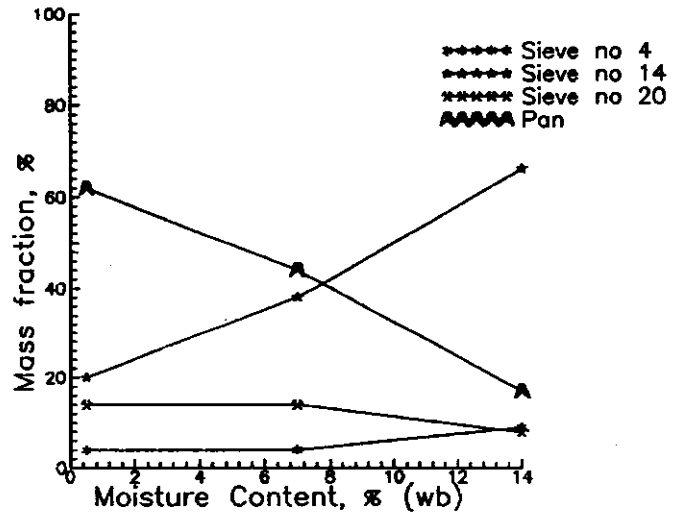

Fig. 4. Sieve analysis of grinding of *makhana* at various moisture content for 1 min

1 min of grinding time and a moisture content 14% in *makhana*. This study has further icated that a maximum amount of uniform dium size particles of *makhana* can be obtained, is ground in domestic grinder (make Sumeet, del sp–16) using dry grinding blade at medium ed for a period of 1 min. The study has also ablished that the need of roasting or frying of *khana* merely for grinding purpose in traditional thod for *makhana kheer* making can be dispensed n, as the normal moisture contents of market mples of *makhana* lie in the vicinity of 12–14% almost all the seasons of the year and could ground to desired particles size in domestic nder easily.

References

Gopalan C, Ramasastri BV, Balasubramanian SC (1987) Nutritive Value of Indian Foods. National Institute of Nutrition, Hyderabad

Hall CW (1970) Drying Farm Crops. Lyall Book Depot Publication, Ludhiana

Jha SN (1993) Development of a processing machine for gorgon nut (*Euryale ferox*). Ph.D. Thesis. Indian Institute of Technology, Kharagpur

Jha SN, Prasad S (1993) Moisture diffusivity and thermal expansion of gorgon nut. J Food Sci Technol, 30(3):163–165

Jha SN, Prasad S (1996) Determination of processing conditions of gorgon nut (*Euryale ferox*). J Agric Engng Res 63: 103–112

Jha V, Barat GK, Jha UN (1991) Nutritional evaluation of *Euryale ferox* salisb. J Food Sci Technol, 28(5):320–328

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