# Nitrification of Defatted and Processed Seed Meals

Studies in nitrification have been carried out with a number of seed meals, defatted and freed of lipids, with a view to assessing the influence of various constituents in the seed on mineralization of nitrogen. Fat appears to retard nitrification in certain cases. Rates of ammonification and nitrification vary in different samples.

In spite of the urgent need for fat and protein to meet the nutritional requirements of the ever-increasing population, the oilseed resources of India have been relatively untapped. Many resources commonly known as nonedible oilseeds belong to the extensively grown avenue trees—e.g., margosa (*Melia indica*)—and the commonly grown Sapotaceous tree, Madhuca.

Preliminary findings encouraged the use of processed seed meals of adequate amino acid composition for cattle and poultry feed, pending studies of their cumulative toxicity, if any (Mitra and Misra, 1967).

A small fraction of these important oilseed resources are processed in isolated villages to produce crude fat for burning in open lamps and infrequently for folk medicines. The less toxic seed materials are sometimes used as cattle feed and the cakes obtained from them are put in the soil, presumably to increase its nitrogen content. Little systematic work has been carried out to determine the manurial value of these seed cakes. Cakes conventionally obtained are loaded with up to 15% of residual fat, as in the villages pressing is generally done with a low pressure oil press. As neither the fat-bearing nuts or seeds nor the fats obtained from them are trade commodities, the organized industry is little interested in pressing these seed materials in high pressure rotaries or expellers for extrusion of the maximum quantity of fat.

These seed meals are not equally rich in nitrogen, and meals having a nitrogen content below the optimal level can be of little use for enriching the soil. Nitrification of these seed meals in the soil, and the influence of various factors such as the presence of fat have been studied.

## METHODS AND MATERIALS

Processed meal was obtained as a residue (powder) after extraction of the decorticated seed kernel meal successively with *n*-hexane and 90% alcohol.

Defatted meal was obtained by extraction of the decorticated seed meal with hexane in a Soxhlet apparatus.

The screw press is a contrivance for extruding fat from the decorticated seed kernel (coarsely powdered) in a manually operated, vertical type press about 10 inches in diameter and 16 inches in depth, generally used in a cottage industry. This is a comparatively low pressure operation.

Whole kernel powder is untreated seed kernel meal containing all the fat as well as the alcohol-soluble constituents.

The untreated virgin soil was selected from the National Botanic Gardens for these experiments. In general, the Lucknow soil (latitude 21° East, longitude 81°; a valley on the river Gomati, bounded on both sides by nodules of limestone rising 40 to 50 feet from the river bed; average annual rainfall, 100 cm.) is a richly cultivated light alluvial loam interspersed with patches of sand and heavy clay (Anderson, 1859; Nevill, 1922). The soil sample had a pH 7.8, 1.3% moisture, and 0.05% nitrogen.

In each experiment organic material (40-mesh BSI) equivalent to 30 mg. of nitrogen per 100 grams of soil (20-mesh BSI) (50 mg. of nitrogen equivalent per 100 grams of soil in the case of *Arachis hypogea*) was mixed thoroughly with the tared soil samples. The experiments were carried out at room temperature in 1-liter glass jars with screw caps perforated for aeration. The moisture content was adjusted when necessary at one third the water-holding capacity of the soil by adding water to make up for the difference in weight on every seventh day.

Ammoniacal and nitrate nitrogen were estimated at intervals according to Richardson's modification of Olsen's method (Piper, 1955).

Two sets of experiments were carried out for nitrification studies. In one set, processed seed meals (Mitra and Misra, 1967), including similarly treated *A. hypogea* meal, were taken for comparison. Studies were carried out during July-September with maximum atmospheric humidity (30 to 100%). In another set of experiments partially defatted (obtained from a screw press which leaves a substantial quantity of fat in the cake) and whole-kernel meals were used to determine the influence of fat during nitrification. The latter experiments were carried out during the drier months, February to April (humidity 5 to 30%).

**Table I. Mineralization of Organic Nitrogen Added to Soil[a]**

| Material | Nitrogen, % | Fat, % | Nitrogen, P.P.M. in Oven-Dry Soil | | | | | | | | | | | | | | | | | | Total N Mineralized, % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $NH_4$ | $NO_3$ | Σ | $NH_4$ | $NO_3$ | Σ | $NH_4$ | $NO_3$ | Σ | $NH_4$ | $NO_3$ | Σ | $NH_4$ | $NO_3$ | Σ | $NH_4$ | $NO_3$ | Σ | |
| | | | 1 Week | | | 2 Weeks | | | 3 Weeks | | | 4 Weeks | | | 5 Weeks | | | 7 weeks | | | |
| *Jatropha curcas* (processed) | 9.3 | Nil | 3.3 | 59.0 | 62.3 | ±0 | 134.8 | 134.8 | ±0 | 153.0 | 153.0 | ±0 | 159.5 | 159.5 | ±0 | 164.5 | 164.5 | 1.8 | 159.7 | 161.5 | 54.9 |
| *Sleichera oleosa* (processed) | 6.5 | Nil | 24.5 | 10.3 | 34.8 | ±0 | 56.0 | 56.0 | ±0 | 69.2 | 69.2 | ±0 | 75.2 | 75.2 | ±0 | 81.1 | 81.1 | 1.2 | 90.7 | 91.9 | 30.6 |
| *Melia indica* (processed) | 7.0 | Nil | 3.92 | 83.0 | 86.92 | ±0 | 125.0 | 125.0 | ±0 | 139.0 | 139.0 | ±0 | 144.0 | 144.0 | ±0 | 152.0 | 152.0 | 1.2 | 149.7 | 150.9 | 50.7 |
| *Sarcostigma klenii* (processed) | 5.9 | Nil | 2.6 | 39.2 | 41.8 | ±0 | 60.0 | 60.0 | ±0 | 73.9 | 73.9 | ±0 | 80.2 | 80.2 | ±0 | 85.6 | 85.6 | 1.2 | 91.8 | 93.0 | 31.0 |
| *Salvadora oleoides* (processed) | 5.0 | Nil | 3.3 | 64.0 | 67.3 | ±0 | 102.7 | 102.7 | ±0 | 115.6 | 115.6 | ±0 | 126.7 | 126.7 | ±0 | 133.7 | 133.7 | 1.2 | 140.7 | 141.9 | 47.3 |
| *Arachis hypogea* (processed) | 8.5 | Nil | 3.2 | 103.3 | 106.5 | ±0 | 154.4 | 154.4 | ±0 | 166.0 | 166.0 | 0.65 | 171.1 | 171.8 | ... | ... | ... | ... | ... | ... | 57.3 |
| 50 mg./100 g. | 8.5 | Nil | 58.4 | 167.0 | 225.4 | 2.6 | 150.1 | 152.7 | 0.6 | 153.0 | 153.6 | 0.65 | 164.0 | 164.7 | ... | ... | ... | ... | ... | ... | 32.9 |
| *Jatropha curcas* | | | | | | | | | | | | | | | | | | | | | |
| Processed | 9.3 | Nil | 58.2 | ±0 | 58.2 | 28.5 | 55.7 | 84.2 | 3.2 | 83.2 | 86.4 | 1.3 | 177.0 | 178.3 | ±0 | 186.3 | 186.3 | ±0 | 190.7 | 190.7 | 63.6 |
| Defatted | 8.0 | Nil | 51.9 | ... | 51.9 | 17.7 | 54.4 | 72.1 | 1.9 | 108.4 | 110.3 | 1.3 | 158.4 | 159.7 | 0.6 | 178.3 | 178.9 | 0.6 | 195.5 | 196.1 | 65.4 |
| Screw-pressed | 6.0 | 25 | 21.1 | ... | 21.1 | 30.6 | 12.1 | 42.7 | 3.2 | 86.0 | 89.2 | ±0 | 116.0 | 116.0 | ±0 | 133.0 | 133.0 | ±0 | 149.0 | 149.0 | 49.7 |
| Whole kernel | 4.8 | 40 | 1.9 | ... | 1.9 | 7.0 | ... | 7.0 | 5.1 | 12.7 | 17.8 | ±0 | 53.6 | 53.6 | ±0 | 83.7 | 83.7 | ±0 | 111.1 | 111.1 | 37.0 |
| *Gossypium indicum* | | | | | | | | | | | | | | | | | | | | | |
| Processed | 8.5 | Nil | 100.6 | 13.7 | 114.3 | 1.9 | 118.1 | 120.0 | 1.9 | 133.6 | 135.5 | 1.2 | 163.7 | 164.9 | 0.8 | 223.0 | 223.8 | ... | ... | ... | 74.6 |
| Defatted | 7.8 | Nil | 94.9 | 7.4 | 102.3 | 4.5 | 99.2 | 103.7 | 3.2 | 120.4 | 23.6 | ±0 | 135.2 | 135.2 | ±0 | 144.8 | 144.8 | ... | ... | ... | 48.3 |
| Screw-pressed | 6.6 | 21 | 75.2 | ±0 | 75.2 | 1.3 | 72.2 | 73.5 | 0.6 | 101.3 | 101.9 | ±0 | 112.1 | 112.1 | ±0 | 117.2 | 117.2 | ... | ... | ... | 39.1 |
| Whole kernel | 5.4 | 30 | 47.6 | ... | 47.6 | 3.9 | 36.1 | 40.0 | 1.3 | 72.2 | 73.5 | ±0 | 84.1 | 84.1 | ±0 | 85.4 | 85.4 | ... | ... | ... | 28.5 |
| *Pongamia glabra* | | | | | | | | | | | | | | | | | | | | | |
| Processed | 6.0 | Nil | 43.0 | ±0 | 43.0 | 3.2 | 52.3 | 55.5 | 1.3 | 88.6 | 89.9 | 1.3 | 101.0 | 102.3 | ±0 | 105.2 | 105.2 | ... | ... | ... | 35.1 |
| Defatted | 5.45 | Nil | 60.0 | ±0 | 60.0 | 4.5 | 67.1 | 71.6 | ±0 | 115.0 | 115.0 | ±0 | 131.2 | 131.2 | ±0 | 135.1 | 135.1 | ... | ... | ... | 45.0 |
| Screw-pressed | 4.3 | 28 | 39.8 | ... | 39.8 | 5.8 | 44.1 | 49.9 | ±0 | 68.3 | 68.3 | ±0 | 83.6 | 83.6 | ±0 | 99.7 | 99.7 | ... | ... | ... | 33.2 |
| Whole kernel | 3.6 | 34 | 3.1 | ... | 3.1 | 7.1 | ... | 7.1 | ±0 | 7.6 | 7.6 | ±0 | 16.2 | 16.2 | ±0 | 33.7 | 33.7 | ... | ... | ... | 11.2 |
| *Madhuca latifolia* | | | | | | | | | | | | | | | | | | | | | |
| Processed | 5.0 | Nil | | | | | | | | | | | | | | | | | | | |
| Defatted | 2.75 | Nil | No nitrification took place within 7 weeks. | | | | | | | | | | | | | | | | | | |
| Screw-pressed | 2.7 | 15 | | | | | | | | | | | | | | | | | | | |
| Whole kernel | 1.6 | 43 | | | | | | | | | | | | | | | | | | | |

[a] 30 mg. N added/100 g. soil unless otherwise indicated.

The processed seed meals were selected from different botanical families on the basis of their nitrogen content. Similarly, the four seed meals—*Jatropha curcas*, *Gossypium indicum*, *Pongamia glabra*, and *Madhuca latifolia*—having different fat contents as noted in Table I were studied exhaustively to evaluate their suitability for the mineralization of nitrogen.

## RESULTS AND DISCUSSION

Results of this preliminary study (Table I) give the per cent of nitrogen mineralized during the experiments and the details of ammonification and nitrification in every successive week during the investigation. *Madhuca latifolia* (mahua) seed meal appears to be of little practical value as a manure, as evidenced by its lack of nitrification of the available nitrogen.

Commercial "oil cakes" having an oil content above a certain level have been reported to interfere with the mineralization of organic nitrogen, although no well laid out experiments or results thereof are recorded in the literature (Gandagule, 1960; Indian Council of Agricultural Research, 1961). The authors have observed, in certain cases, that the totally defatted and processed meals showed maximum nitrification compared with the undefatted or partially defatted meals. This observation, if substantiated by further critical studies, would be of significance in the economic utilization of these oilseeds. The rate of nitrification or the amount of total nitrogen made available to the soil does not necessarily depend upon the nitrogen content of the organic material used. The rate of ammonification and successive nitrification also varies.

As the present experiments were carried out primarily to study the nitrification of the processed seed meals, care was taken to remove the nonfatty and nonproteinous organic matter as far as possible by treating the kernel powder with dilute alcohol (90 to 95%) and defatting with hexane (Soxhlet). Organic metabolic inhibitors, if any, in the seed or nut kernel might have been removed during processing with dilute alcohol or hexane, but that did not vitiate the results, as all the meals investigated were processed under identical conditions. Studies in nitrification of processed seed meals for a longer period are in progress.

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