

Ragi, *Eleusine coracana* Gaertn.,—A New Raw Material for the Malting Industry

BARLEY, *Hordeum sativum*, occupies the pride of place among the cereals as raw material *par excellence* for malting both in the brewing and the food industries. Attempts have been made, from time to time, to employ other cereals, wheat, rye, rice, etc., but none of these has, to any serious extent, affected the pre-eminent position occupied by barley.

While it is possible that there are sound reasons for its continued employment in a highly specialised field such as the brewing industry, the possibility of substituting or supplementing barley in the food and pharmaceutical industries deserves careful consideration. This problem is of particular interest to India where barley is by no means an extensive crop, only a little over 6 million acres, confined to four provinces (United Provinces, Bihar, Orissa and the Punjab) in North India, being under cultivation. Barley is not cultivated in South India except, perhaps, for a small tract in the Nilgiris. The three principal millets of India, *viz.*, *cholam* (*Andropogon sorghum* Brot.), *bajra* (*Pennisetum typhoideum* Rich.) and *ragi* (*Eleusine coracana* Gaertn.), together occupy over 57 million acres, and any possibility of employing these starchy food grains in the malting industry demands special consideration. India imports, annually, over Rs. 24 lakhs worth of farinaceous and invalid foods of which malt is the primary constituent, and for these reasons, investigations on the malting of the more abundantly available cereals is of interest to India, in general, and to South India, where barley is not cultivated, in particular.

Work in this field was first started in the Agricultural Research Institute, Coimbatore, in 1917. At the Madras Exhibition, 1917, the Government Agricultural Chemist exhibited a number of malted foods, containing the malts prepared from *cholam* and *ragi* as the essential ingredients.¹ Investigations relating to malting have continued to occupy the attention of the Agricultural Research Institute, Coimbatore, ever since.

The relative merits of *cholam*, *bajra*, *ragi* and other locally available millets were examined by Viswanath, Rao and Ayyangar,² who reported that while both *cholam* and *ragi* could be adapted for malting, the former is to be preferred in view of the bigger size of the grain and the absence of any tendency to felt in the malting tray.

Investigations relating to the chemical examination of Indian foodstuffs were initiated by Prof. Roland V. Norris, at the Indian Institute of Science, Bangalore, in 1925. The work was carried out under two main lines, (1) the isolation, analysis and biological assay of the proteins of the foodstuffs, and (2) the study of the enzymes of the resting and germinated materials. The studies revealed that *ragi* contained a prolamins of high biological value³ and that germination led to the production of a highly active diastase, more potent than that from *cholam*. These two observations prompted the Institute workers to re-examine the malting qualities of *ragi* with a view to manufacture from it a satisfactory malt extract suitable for employment in the food and pharmaceutical industries.

Eleusine coracana, *ragi*, is an extensively cultivated millet occupying over 7 million acres, of which nearly 72 per cent. lies in Madras and Mysore. It is the premier crop of the Mysore State, and is perhaps the cheapest food grain on the market, with a traditional reputation as a nutritious and sustaining food. A variety of *eleusine* is cultivated in Africa and feeding experiments conducted by Orrù⁴ have shown that rats, maintained exclusively on a diet of *eleusine*, kept in good condition and showed a considerable increase in weight (209 per cent. average increase in 65 days). Camis⁵ studied the vitamin content of *Eleusine coracana* and records that pigeons fed on

¹ Sivan, *The Agric. J. India*, 1919, 14, 71.

² Viswanath, Rao and Ayyangar, *Mem. Dep. Agr. Indic, Chem. Ser.*, 1918, 5, 117.

³ Nfyogi, Narayana and Desai, *Ind. J. Med. Res.*, 1934, 22, 373.

⁴ Orrù, *C. A.*, 1929, 23, 3753.

⁵ Camis, *Ibid.*, 1935, 28, 6781.

vitamin B₁-free diet recovered in 2-5 days after feeding on *ragi*. Luigi Massa⁶ mentions that *E. coracana* is employed for preparing a fermented liquor, similar to beer, in Africa. The protein of *ragi* contains phosphorus, and recent work⁷ at the Nutrition Research Laboratory, Coonoor, has shown that among the cereal proteins, the one from *ragi* is the best for the maintenance of the adult rat.

From what has been said above, it will be seen that the merits of *ragi* as a raw material for malting, assert themselves for consideration, and the work carried out at the Institute, which has now reached a successful stage, was directed to a study of the conditions necessary for obtaining maximum transformation during the malting of the grain.

The sequence of operations leading to the production of malt runs as follows:—40 hours steeping, flooring for 5-6 days, controlled kilning for 24 hours and final curing at 95° C. for 30 minutes. The resulting malt has an extremely agreeable aroma, yields 74 per cent. extract and possesses good keeping qualities.

The smallness of the grain necessitates a thick spread (3") of the grain with frequent ploughing to ensure evenness of germination. Drum germination gives better results. Under these conditions there is no tendency to felt and a uniformly germinated product results. The smallness of the grain is a decided advantage in kilning, tending not only to minimise fuel costs but also ensuring uniform drying. Under properly controlled conditions, the malting loss does not exceed 15 per cent.

Malt products.—Extract. Conditions for preparing malt extract have been worked out. Best results are obtained by percolation at 70° C. with water added in proportion of 1 part of broken malted grain to 8 parts of water. Final filtration in a Seitz filter gives a water-clear extract containing

nearly 10 per cent. total solids. Several semi-commercial-scale trials have been successfully conducted in the Department. More recently, concentration of one batch of malt liquor has been carried out in Scott's patent Forced Circulation Evaporator, which was made available to us through the kind courtesy of the Government Industrial and Testing Laboratory, Bangalore. A clear, honey-coloured product, ref. index 1.4906 at 25° C., and Sp. Gr. 1.40 at 25° C. was obtained.

The nitrogen content of the extract was found to be 3.5 per cent., somewhat below the specification given in the *British Pharmacopœia*. This is due to the fact that *ragi* (H. 22) employed for this work is poor in nitrogen. A number of varieties of *ragi*, obtained through the kind courtesy of Rao Bahadur G. N. Rangaswami Ayyangar, Millet Specialist, Government of Madras, have since been examined for their nitrogen content, and two varieties, E.C. 1540 and E.C. 2928, with nitrogen contents of 2.27 and 1.83 respectively, have been selected for malting trials. It is pertinent to point out that both these varieties are white, and possess good malting qualities.

I should like to associate with this investigation, the names of Messrs. N. Narayana, A. Krishnamurthy and more recently Mr. S. Srinivasa Rao. Special mention, however, must be made of Mr. A. Krishnamurthy, who was largely responsible for determining the optimum conditions for malting. A variety of invalid and "vitaminised" malt foods were exhibited at the Mysore Dasara Exhibition, 1935. These researches would not have reached the present stage, but for the enthusiastic co-operation of Mr. M. Sreenivasaya, the keen interest evinced by Sir C. V. Raman, and the kind and continued encouragement of Rao Bahadur B. Venkatesachar.

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⁶ Massa, *Ibid.*, 1935, 29, 6959.

⁷ Swaminathan, *Ind. J. Med. Res.*, 1938, 26, 113.