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Ad-Hoc Expert Group Meeting on the
Research and Development of a Small-Scale
Low-Cost Rice Bran Stabilizing Unit

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RICE BRAN STABILIZATION[1/]. ((977).

by

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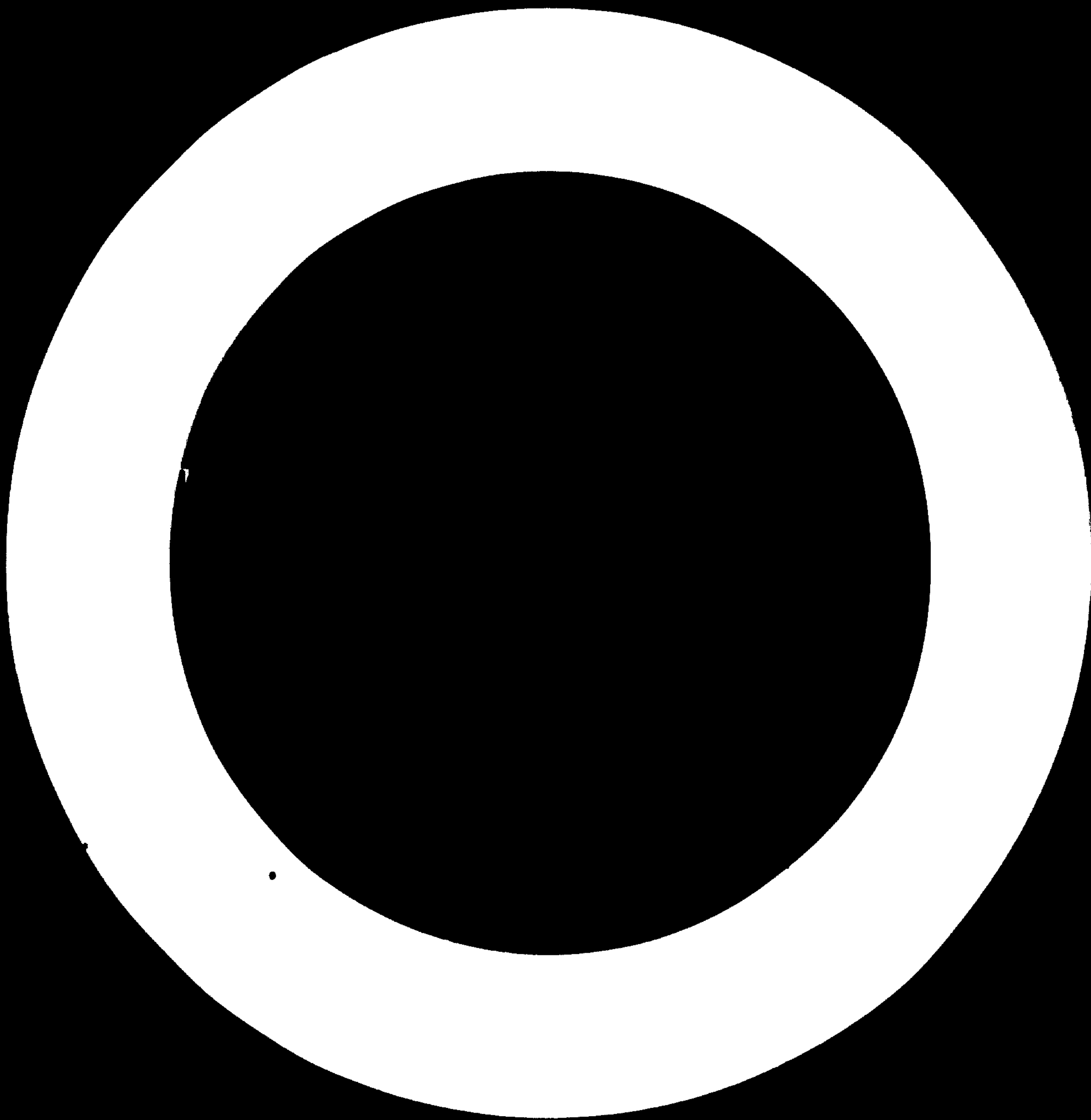
Introduction

This paper has been prepared as a contribution to the work of the Ad-hoc Expert Group Meeting on the Research and Development of a Small-Scale Rice Bran Stabilisation Unit, created by the Development and Transfer of Technology Section of UNIDO.

UNIDO's initiative is inspired by the wish to develop appropriate technology for rice bran stabilisation whereby it would be possible to conserve the 8 million tons (estimated) of rice bran which currently remain unused in the rural areas of developing countries; thus, an additional 1.8 million tons of crude vegetable oil or 1.6 million tons of edible oil could be made available for human consumption in addition to some 6 million tons of rice bran meal for animal feed (1). This, however, must be viewed as a long-term objective requiring marked changes of pattern of rice utilisation in rural areas. Currently the greater part of the bran in question is produced by domestic or village processes using traditional pounding equipment or Engleberg type hullers; and it would be unrealistic to suppose that stabilised bran could be recovered generally as a by-product of these processing operations. For the present, therefore, the attention of the Ad-hoc Group has been directed to the need for equipment "suitable for attachment to existing small-scale rice mills; operational with minimum levels of labour, skill and attendance; and with no external fuel requirements". In interpreting these guidelines, the Group has accepted the ASRCT suggestion that it should consider plant scaled to a bran input of 75kg/hour.



Definition of "Stability"

In the present context "stability" is a relative term. It means the absence of appreciable lipolytic or oxidative changes - and consequential degradations - in bran during a specified period of time. It is important to bear in mind that nothing is gained by conferring on rice bran a greater degree of stability than is necessary; it is of no value that a batch of bran would keep for six months if, in fact, the entire batch is to be solvent extracted or fed to animals within one week. Some margin of safety must be allowed, however, in case unforeseen delays arise.

In deciding the desirable period of stability for a particular set of local cercumstances, great emphasis should be placed on the importance of proper phasing of operations. In general, this will be less problematical where the bran is destined for solvent extraction. Only two principal parties are concerned - the rice miller and the edible oil manufacturer - and where stabilisation is practiced it is likely that both are sufficiently enlightened to appreciate the mutual benefits which it confers on them. The objective must be to complete the sequence:

1. Rice milling
2. Further processing of bran
3. Storage of bran at mill
4. Transport of bran to extraction plant
5. Storage of bran at extraction plan
6. Extraction of oil from bran

with the minimum of delay. In particular, there must be as near as possible to zero delay between operations 1 and 2. Under favourable circumstances, the sequence could be completed in a few days. For the purposes of a general analyses, it would seem reasonable to assume a maximum period of three weeks.

Where bran is used as animal feed in the vicinity of the mill, turn-over of stocks may be so rapid that the case for stabilisation is a weak one. However, where the bran enters a marketing chain for ultimate use as a feed, a relatively high degree of stability is required. A maximum period of two months between milling and consumption as feed is a reasonable general assumption.

The Stabilisation Process

Operation 2 is widely regarded as constituting the stabilisation process. This is incorrect, however, for the conditions to which bran is exposed during storage and transportation also influence its stability. For a balanced assessment of the subject, it is necessary to realise that stabilisation is a multi-stage process comprising operations 2 - 5

Heat Treatment

The lipolytic and oxidative changes which occur in untreated bran are catalysed by enzymes which are constituents of the bran or which are present in micro-organisms feeding upon it. The changes can be arrested by inactiviting the enzymes, or by creating conditions within the bran unfavourable to the reactions which they catalyse. For all practical purposes the latter course equatesto reduction of the moisture content of the bran by application of heat; and indeed application of heat, with control of moisture content, is the only practical method of enzyme inactivation in this instance.

The Ad-hoc Group is concerned with the manufacture of equipment. Its task would be a relatively straightforward one if there were general agreement on the conditions which must be achieved in processes to inactivate enzymes in bran or to suspend their catalytic action. The survey conducted by ASRCT (2) reveals, however, many apperent contradictions between the findings of the numerous studies which have been made in this subject.

These apparent contradictions are partly explicable in terms of the variability of rice brans. The chemical composition and physical properties of a batch of bran relate to some extent to the variety of rice from which the bran was milled; they are also affected by the nature or the milling process employed, the type of equipment used, the efficiency of operation and the standards of maintenance in the mill in question. A broad distinction must be made between rice milled from raw paddy and that milled from parboiled rice; but within these two categories there are wide variatious in composition of which varation in starch content and condition is probably the most significant factor. In consequence the heat transfer properties of brans vary widely, as does the tendency of individual particles within the different brans to adhere to adjacent particles when subjected to treatment by dry heat or live steam.

Enzyme inactivation processes in general have involved the application of heat with an initial addition of moisture. This procedure has been adopted because the heat sensitivity of enzymes is greater at moisture content levels somewhat above those found in freshly milled bran. Steam has usually been employed as the source of the additional moisture because of its favourable heat exchange characteristics. Probably the poor results obtained by many of the processes reported in the literature has been due to the presence in treated bran of particles which have remained untreated or incompletely treated because of the insulating action of other adhering particles. Barber (3) has reported a process in which this problem has been overcome, as demonstrated in pilot plant operations carried out in Spain. The process involves conditioning of bran to an initial moisture content of 16 % by treatment with live steam in a heated vessel. Uniformity of treatment is obtained by continuous agitation of the bran.

Enzyme inactivation can be achieved, however, by mixing bran and water in the required proportions and then applying dry heat. This procedureis likely to prove attractive from the standpoint of the development of a method suitable for use in small mills.

Particular attention would have to be paid to securing uniformity of moisture content within the bran.

Simple suspension of enzyme activity has generally been obtained by partial dehydration of bran through application of dry heat. Various degrees of moisture reduction have been proposed, and it may be concluded that as a general rule these confer differing degrees of stability. The extent of reduction obtained in a particular situation should be ascertained by carefully controlled trials in the first instance. Though uniformity of treatment is not crucial in this case - as it is when enzyme inactivation is sought - it is none the less important that no pockets of high moisture content should remain in the treated bran. ASRCT ( ) has proposed the development of a system in which bran is agitated by a screw conveyor during the heating process; and Barton (3) has suggested the use of a fluidisation system. Both of these methods, but particularly the latter, require further technical investigation before they could be accepted as being of proven suitability.

Idea for a possible simple system for bran dehydration

None of the systems mentioned above conform to all the criteria proposed by UNIDO, namely:

1. Suitable as an attachment to existing small and medium capacity rice mills;
2. An effective stabilization process is to be carried out by technically simple and unsophisticated equipment suitable for manufacture in developing countries;
3. No steam consumption;
4. No electricity consumption;
5. The use of rice mill by-products (husks) as fuel;
6. As far as possible automatic function not requiring (expert) attendance;
7. Easy maintenance - not involving mechanical parts - and limited repairs.

and indeed it may be appropriate for the Group to recommend to UNIDO that the criteria be revised. It may be technically possible, however, to develop a system which does conform to the criteria.

The alternative to fluidisation or agitation of bran is heat treatment in thin layers. At a somewhat more sophisticated level of processing than that with which the Group is concerned, this treatment would best be effected by feeding bran slurries to a drum dryer operating at a suitable temperature. The low technology equivalent of a drum dryer could be a metal chest with a flat upper surface, heated internally by boiling water in it or by feeding exhaust steam (where this is available) to it. Use of these heating media would ensure that, however, careless the operators, the temperature of the upper surface does not rise above 100 ^{o} C.

Around the edges of the upper surface a ridge would be placed of, say 2 mms thickness. During operation, bran would be spread over the surface and then formed into a lightly compacted layer of 2 mm thickness by running a batten supported on the ridges over the surface. Whether or not this system is technically feasible depends on the heat transfer properties of the metal surface/ bran layer. For purposes of illustration, it is assumed that the processing cycle - formation of bran layer, drying operation, removal of dried bran - could be completed in six minutes. If indeed a thickness of 2 mm proves suitable, the yield of bran per square metre per hour would be 0.02 cubic metres - equivalent to about 7 kg. A mill of the type under consideration would then require 11 square metres of heated surface.

In use, such a system would be highly labour intensive, particularly if it were adapted for enzyme inactivation by admixture of bran and water prior to drying. It must be noted, however, that any system which conforms to the original UNIDO criteria must inevitably be labour intensive.

Storage and transport of bran

If bran is stored in a container which provides a barrier to passage of moisture - e.g. a closed metal bin, immediately after heat treatment and cooling operations have been completed, it will retain the degree of stability which the heat process has conferred upon it. If however it is stored in contact with air - e.g. in woven jute sacks - the stability will be affected by the prevailing conditions of temperature and humidity.

This modulating effect of storage conditions arises primarily through moisture transfer between the bran and the surrounding air. A thin layer of bran placed in contact with air of constant temperature and humidity will attain eventually an equilibrium moisture content. Equilibrium moisture content increases with increasing humidity at a fixed temperature and decreases with increasing temperature at a fixed humidity. The curves of equilibrium moisture content against relative humidity and temperature will vary between brans of different origins because of the variation in chemical composition and physical properties noted above; in particular the conditions to which the bran has been subjected in the heating process after milling will influence to some extent the equilibration of the product and the surrounding air. The determination of variation of equilibrium moisture content with temperature and humidity is a simple task which should be carried out to provide essential data wherever bran stabilization is practised.

In general bran stored under ambient conditions in the tropics is likely to equilibrate at a moisture content of 12 per cent or higher. Consequently bran which has been stabilized initially by reduction of moisture content to, say, 8 per cent will absorb moisture from the surrounding air and an increasing proportion of its bulk will attain moisture contents at which enzyme catalyzed deterioration recommences. There is little published information available at present on this stage of the stabilisation process; and clearly there is an immediate need for a study of moisture uptake and of de-stabilisation under normal commercial storage conditions.

There is also a need for further elucidation of the microbiology of stored stabilised bran. This involves attention to all the well established practices of good store-keeping , including:-

- general cleanliness
- use of dunnage for bagged produce
- effective rodent and insect control, including prevention of cross infestation from produce already in the store
- thorough removal of residues from bags prior to re-use
- rigorous observance of the principle; " First In - First Out".

Consideration should also be given to:

- the feasibility of using alternative packaging materials
- the practicability of covering stacks with plastic sheeting in situations in which re-use of woven vegetable fibre bags is unavoidable
- the possible use of simple containers for bulk storage and transportation of bran

References

1. UNIDO memorandum on the work of the ad hoc Group

2. Draft study of the definition of the most suitable rice bran stabilizing technology, its verification and the specification of its technical parameters ASRCT (1976) Group working document

3. Stabilization of Rice Bran, S. Barber (1976) Group working document

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