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SMALL CAPACITY RICE BRAN OIL EXTRACTION PLANTS*

by

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Introduction

1. The use of small capacity rice bran oil extraction plants for the appropriate utilization of rice bran is only one of the many problems that so far have prevented both the rice milling and the vegetable oil industry from making optimum use of the existing rice bran potential. With your permission, Mr. Chairman, I shall, therefore, try to review the overall situation from the view point of efficient processing operations inclusive small capacity plants and outline the conditions that might have to be created to this effect.

I. The raw material "rice bran"

2. Nearly all of the oil contained in the rice kernel is concentrated in the germ, pericarp and polish and the rice bran, therefore, is very rich in oil compared with husked and milled rice. For similar reasons, the rice bran is also rich in protein, B-vitamins and minerals. Because of the fibrous nature of the pericarp, rice bran has a higher fiber content than milled and husked rice. The composition of the rice bran depends on the initial paddy composition and to a very high degree on the rice milling techniques. Rice bran is, therefore, not a clearly defined product.

3. With an average oil content of approximately fifteen per cent, rice bran would in principle, be a valuable raw material for vegetable oil production. The main reason for its under utilization by the vegetable oil industry lies in its instability. Naturally occuring enzymes liberated at the moment of the seperation of the bran layers from the kernels cause rapid hydrolysis of the rice bran oil. The rate of hydrolysis or lypolysis is dependent on the moisture content and storage temperature. Under unfavourable conditions, the free fatty acid content can increase at a rate of one per cent per hour at the first few hours after milling and can reach fifty per cent and more within a month.

II. Rice bran oil and meal

4. Depending on the extraction methods and the extent of bran deterioration, orude rice bran oil is of dark brown to greenish-yellow colour. It contains pigments such as carotenes and chlorophyll which can reasonably well be absorbed by bleaching earth or destroyed by heat treatment.

Oxydation, particularly in the presence of iron, can lead to the colour becoming resistant to many bleaching methods.

5. Rice bran oil is a semi drying oleic/linoleic oil with a comparatively low linolenic acid content (0,5 to 1,0 per cent) which gives it a distinct advantage over cottonseed oil and soya oil (up to ten per cent). Except for its usually high free fatty acid content and unsaponifiable substances crude rice bran oil compares favourably with other "soft" oils if carefully produced and processed.

6. The high content of wax (up to nine per cent) in the crude rice bran oil in addition to the usually high FFA value may cause considerable refining difficulties and losses. The wax needs to be removed during the first stage of the refining process which, therefore, has to consist of five stages than normally four, namely: dewaxing, degumming, neutralization, bleaching and deodorization.

7. More or less successful attempts have been made to isolate and purify the rice bran wax for industrial uses as a carnauba wax replacer and other applications. The isolated rice bran wax, however, has not yet become a competitive trade commodity and more reasearch and development work might be required.

8. While rancid rice bran may be unpalatable to animals, the extracted bran (12 to 14 per cent protein) is a most suitable animal feed despite its fibrous structure. The lower energy content of extracted bran compared with crude bran expressed by total digestible nutrients will be compensated by its stability and easy handling. Along with the steadily increasing world market demand for compounded animal feed extracted rice bran bears in itself a considerable export potential for many countries.

III. The rice bran situation

9. The rice milling sector of most of the paddy producing countries with only few exceptions is characterized by the more or less efficient operation of numerous small rice mills of different technical designs.

Predominantly located in rural paddy growing areas the individual mills operate in isolation from each other and hardly any sectoral organization scheme is visible.

10. Milled rice is considered the only main product of the rice mill while rice bran is an unavoidable by-product. This particular philosophy has resulted in the setting up of technically inefficient rice milling units like the "huller type mill" that, in the first instance, produce white rice and leave a mixture of husk, bran, broken rice and impurities, completely unsuitable for further industrial utilization.

11. Under these circumstances it is most difficult to make available suffioient quantities of fresh quality rice bran for the production of rice bran oil and protein meal. In order to do so, the preconditions have to be created in the rice milling sector by structural improvements, technical up-dating, re-organization of the provisioning and marketing proceedings and product market price adjustments.

IV. The rice bran processing problem

12. When discussing small capacity rice bran oil extraction plants, the following questions necessarily arises. Is the setting-up of such plants an appropriate approach to solving the rice bran utilization problem? Small capacity rice bran oil plants may be more in line with the requirements of the general rice milling situation but would they also meet the requirements of the vegetable oil industry? From this view point, little doubt exists that rice bran is not yet considered a competitive vegetable oil raw material neither for processing in small capacity extraction plants, nor in modern large scale vegetable oil factories.

13. Mainly because of the comparatively low oil content of the rice bran, the most efficient processing technology for the production of rice bran oil is solvent extraction. Continuous solvent extraction plants, very clearly follow the principle of the economy of scale and throughput capacities should at least be up to the level of 100 tons/24 hours. It is, however, not generally possible to make available the

large quantity of fresh rice bran raw material that is needed for efficient processing in solvent extraction plants. These conflicting facts are an additional important reason for the underutilization of rice bran for the production of edible oil. A further disadvantage from the processor's view point is the bran's fine particle structure.

14. The setting-up of small scale, solvent extraction plants in rural rice milling areas for technical and economic reasons can, therefore, hardly be considered a solution to the general rice bran utilization problem, although efforts have been made in this direction by some rice producing countries. One practical solution, however, could be the stabilization of the bran at the rice mill, the organized intermediate storage and transport of the stabilized bran to industrial scale vegetable oil factories combining solvent extraction and vegetable oil refining units.

V. Rice bran stabilization

15. The rice bran stabilization theory is common knowledge in principle. Different heat stabilization methods are practiced in some of the rice producing countries with only limited success. Heavy equipment is normally used, such as steel heating pans with agitators and steam jackets or six stage screw driers. Such equipment is normally operated in connexion with an oil mill forming part of its preparatory unit. The rice bran arrives at the vegetable oil factory already with an FFA content of at least ten to fifteen per cent and its stabilization at this stage does naturally not meet its purpose.

16. Appropriate rice bran stabilization has to take place at the rice mill and should form part of the rice milling process. Suitable equipment has to be developed for this purpose, the principle criteria of which are small capacities low energy consumption, continuous operation with hardly any labour attendance and simple design requiring very limited maintenance and repairs. The stabilization equipment, for economic and social reasons, cannot become a financial burden to the rice miller but has to enable him to sell stabilized rice bran to a more favourable but still low enough price to guarantee the economic feasibility of the solvent extraction process to follow.

VI. The solvent extraction technology

17. Modern solvent extraction plants are based on the technological principle of continuous counter-current extraction of an oil bearing raw material using hexane as a solvent. In order to give the solvent access to the oil the cell structure of the oilseed raw material needs to be softened and ruptured by a suitable preparatory treatment. These proccedings have to be different in the case of rice bran the undesirable fine particles of which make direct extraction in continuous extractors difficult. In the case of rice bran, therefore, the preparatory milling or flaking proceedings have to be replaced by pelletizing or granulating.

18. During the extraction process, the oil is dissolved by the solvent forming the "miscella" which is an oil-hexane solution of approximately twenty to twenty five per cent. The appropriately applied counter-current process, because of fresh solvent coming into contact with the already pre-extracted bran, guarantees a residual oil content in the extracted meal of less than one per cent and, therefore, gives the highest possible yield.

19. Hexane is an inflammable solvent and certain essential safety and security measures have to be carefully observed although modern solvent extraction plant designs give a very high degree of processing security.

20. The extracted rice bran pellets which remain rather stable during the hexane treatment are de-solventized under vacuum until they are completely free of solvent. The pellets, after milling - if required - form a dry light-brown meal that is easy to be stored and transported and is not liable to any deterioration under normal circumstances.

21. The miscella undergoes a usually three stage vacuum distillation during whioh the solvent is seperated from the oil and re-circulated to the extractor. The orude rice bran oil should preferably be filtered, dewaxed and de-gummed and further refined - neutralized, bleached and deodourized as soon as possible. Long intermediate storage of the crude rice bran oil especially in mild steel tanks should be avoided.

VII. Continuous percolation type extractors

22. Modern percolation type extractors are suitable for the extraction of rice bran pellets. The solvent or miscella respectively percolates through a stationary bed of rice bran pellets thereby causing only a minimum of pellet damage and production of fines. The stationary bed additionally acts as a miscella filter as most of the fines contained therein are caught by the bed of rice bran pellets. Percolation type extractors, therefore, have the advantage of not requiring special miscella filter units.

23. The miscella when leaving the extractor is, however, not completely free of fines that might in the course of time block the condensors and coolers wich, therefore, should be equipped with removable pipe-packages easy to be cleaned and maintained. The same applies to the meal dis-solventizing units.

VIII. Continuous immersion type extractors

24. The common immersion type extraction system appears to be less suitable for the solvent extraction of rice bran pellets. The rice bran raw material has to be moved counter-current to the miscella or solvent flow through the extractor. The movement of the solid pellets through the liquid solvent cause a "washing effect" combined with considerable friction necessarily resulting in a part damage of the pellets and the production of considerable amount of fines. As no self-filtration effect takes place, the installation of a miscella filtration unit becomes unavoidable. No matter on what system miscella filtration units are based, they are always very difficult to operate and necessarily cause unreasonably high solvent losses very unfavourably effecting the production costs of a rice bran processing immersion type solvent extraction plant.

25. It goes without saying that the operation of miscella filtration units normally guarantee a clean miscella and hardly any harm can be done to the miscella side of condensors and coolers. The crude oil will contain less impurities, but the filtration of crude rice bran oil is definitely easier to handle than the filtration of miscella.

IX. Batch extractors

26. Batch extraction plants, without any doubts, are technically outdated by now. The system has been over-ruled by new technical developments and only very few batch extraction plants are still in commercial operation. It is interesting to note but not at all surprising that the majority of the still operational batch extraction plants hardly process any other oilseeds but rice bran.

27. This situation is the result of the call for small capacity extraction plants that can process a raw material with a fine powdery particle structure like rice bran. This approach, I am convinced, was fully justified at the time when the rice bran processing industry was very successfully established in Japan. Since then, however, new developments took place and other yard sticks are being used to measure the efficiency and usefullness of industrial oilseed processing operations.

X. The rice bran pelletizing process

28. Rice bran needs to be pelletized prior to processing in modern solvent extraction plants. Following the very true formula, "the better the preparation, the better the extraction", the pelletizing process should be carefully executed by conditioning of the bran, pelletization, and drying of the pellets. Three to four millimeter diameter pellets are the optimum size for extraction in percolation type solvent extractors. Attention is drawn in this context to the fact that parboiled bran cannot easily be pelletized and similar difficulties have also been met with stabilized (heated) bran. The pelletizing properties of the different rice bran varieties have not yet been fully explored and further applied research work is required on this particular issue.

XI. Mechanical processing of rice bran

29. The commonly known mechanical screw presses are not normally suitable for rice bran processing. The fine particle structure of the bran does not permit the timely correct build-up of the required pressure between screw and strainer inside the press. It might admittedly be possible to

modify the press design and make it technically suitable for rice bran processing. In any case an undesirable very intensive heating or cooking of the rice bran prior to pressing is essential and the oil yield can hardly exceed fifty to sixty per cent as no lower residual oil content in the press cakes than five to seven per cent can practically be expected. The electricity consumption is high and the unavoidable wear and tear necessitates considerable spare part stocks and supplies.

XI. Conclusion

30. The global utilization of rice bran for the production of edible oil and quality protein meal is a very complex problem. Some more applied research, economic evaluation and technological development work will be required in order to come to practical solutions. The problem starts with the improvement of the rice milling process and ends with the production of rice bran edible oil and feed meal at production costs that permit the marketing of competitively priced quality products.

31. Under very special conditions the setting up of techno-economically efficient smaller capacity single purpose rice bran oil extraction plants may be called for. The more suitable way of rice bran processing, however, appears to be medium or even larger scale multi-purpose vegetable oil factories combining solvent extraction with oil refining operations. In any case, the crucial point doubtlessly is the conversion of the low value by-product rice bran into a quality product of the rice mill and raw material of interest to the vegetable oil industry. The development of suitable rice bran stabilization techniques as an integrated part of the rice milling process and the application of useful transport and storage methods for stabilized bran are expected to play a very important role in this connexion.

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