Processing of Castor Beans

JOHN W. DUNNING, The V. D. Anderson Company, Cleveland, Ohio

DURING the last several years the use of castor oil or its derivatives has been extended to a large number of products. These products include paints and varnishes, plastics, fibres, cosmetics, hydraulic fluids, fungicides, etc. The increased demand for castor oil by these and other uses has emphasized the desirability of a domestic supply of this oil from the standpoint of assurance of supply, as well as of increased supply.

The agronomists and plant breeders have provided castor bean varieties and cultural methods which make a domestic crop possible. On the other hand, there is very little information available on standard methods of processing this crop to provide the usable castor bean oil. The lack of standard processing information can be attributed primarily to the physical nature of the castor bean, which poses several problems with respect to continuous, mechanical processing. For example, the bean contains a very brittle shell or seed coat, which is erosive to mechanical screw press parts. In addition, the oil-bearing kernel of the bean contains protein, oil, and moisture in such physical composition that it is difficult to press the oil from the other fluid constituents of the kernel. These problems are further increased because the seed coats of the castor beans shipped into the United States from South America, for example, appear to become more brittle and more abrasive during shipment. This change requires that the imported beans be processed differently than those remaining in the native country.

There are mills throughout Mexico and Central and South America that are presently processing castor beans in mechanical screw presses. These mills either single- or double-press this commodity.

For the double pressing of castor beans, the beans, after cleaning, are warmed to approximately 150°F. and immediately pressed or prepressed in a mechanical screw press. The oil obtained in this operation is of No. 1 quality and may be filtered readily if warmed to 120°F. and treated with a small amount of filter aid prior to filtering. The prepress cake from this operation contains approximately 20% oil. This cake is heated at approximately 200°F. to dry the moisture from the cake to 4 to 5%. This cake is then pressed again to furnish a No. 3 quality oil and press cake containing 5 to 7% residual oil. The No. 1 quality castor oil referred to in this article has a maximum acid number of 4 and a maximum Gardner color of 3. The No. 3 castor oil referred to has a maximum acid number of 10 and a maximum Gardner color of 7.

Those plants that single-press castor beans may first clean the beans and dry the beans whole to a moisture content of 4 to 5%, at temperatures of approximately 200°F. The beans are then sparged with live steam to increase their moisture content to 5 to 6%. The conditioned beans are then directly pressed in a mechanical screw press to furnish cakes containing 6½ to 8% oil at 8% moisture content. The oil from the single press operation is of No. 1 quality and may be readily filtered at 100 to 120°F. after the addition of a filter aid. It is claimed that mechanical screw presses can handle 30 tons of beans per 24-hr. day and produce cakes containing approximately 7% oil. The mechanical screw presses, which are used for single-pressing of castor beans, require 2 to 3 shaft and barrel changes each year.

When these South American castor beans are imported into the United States however, a different situation exists because of the increased brittleness of the shell. About 12 years ago an attempt was made to process these imported beans in an Expeller. This work was conducted on a commercial scale with a Super Duo Expeller unit. Although it was possible to produce No. 1 quality oil and reasonably low residual oils in the press cake, the extreme brittleness of the shell made it necessary to reline the Expeller barrels and replace the shafts every two or three days. This situation, of course, was untenable.

Because of this problem these imported beans for years have been pressed in a combination cage press and solvent extraction plant. The beans, after cleaning, are warmed to 100 to 115°F. and prepressed in cage presses. The No. 1 quality and medicinal quality castor oil produced in the States results from this prepress operation. The cage press cake is then heated, dried, and solvent-extracted for the recovery of the remaining oil. This solvent-extracted oil is of No. 3 quality.

In recent years The V. D. Anderson Company made a thorough study of the processing of imported castor beans. This study indicated:

1. The obvious fact that the brittleness of the shells of the imported castor beans is responsible for the extreme erosion of the Expeller parts.
2. The inner lining of the castor bean shell contains a pigment, which, in the presence of moisture and heat, gives up its color to the oil.
3. A cooking procedure similar to that developed for the cooking of cottonseed meats transforms the heterogeneous protein, oil, moisture nature of the castor bean meat into a tough mass from which the oil can readily be pressed.

A process was therefore developed for recovering oil from imported castor beans, which consisted of first cleaning the beans, decorticating, cooking and drying the meats, then directly pressing the treated meats in the Expeller. It was found that this mode of operation permitted recovery of No. 1 quality castor oil and the production of press cakes containing 4½ to 5% residual oil.

The decortication of the castor bean however has given considerable trouble since the complete separation of the meat particles from hulls has thus far been impossible. To date the most efficient work known to the author is accomplished by the use of an impact decorticator. This type of decorticator has given satisfactory operation over 16- to 18-hr. periods of time. At the end of this period of time the decortication operation must be closed down for 15 to 20 minutes for cleaning of ducts from the separator. After the meat particles are swept from the ducts, the unit may then be placed into operation again.

The separated castor bean meats or kernels are cooked in a manner similar to the cooking of cottonseed meats. The moisture content of the castor bean meats during the cooking operation however must be

maintained at or above 15%, and the temperature of the cooking process must be maintained at or slightly below 175°F. These cooking conditions are necessary since the overheating of the kernels will cause an excessive flow of oil and thereby result in a very fluid mass that is impossible to handle in the mechanical screw press. Since the castor bean meats are cooked more or less whole, they require double the cooking time as used for cottonseed meats. The cooked meats are then dried, preferably below 215°F. to a moisture content of approximately 4%. They are then conveyed to the Expeller and pressed. Under these conditions a Super Duo Expeller can process the meats from 25 to 30 tons of castor beans in a 24-hr. day.

About two years ago a sample of castor beans grown in the Southwest United States was sent to The V. D. Anderson Company for testing. It was found that the shell of these domestic seeds was thinner and much softer than the imported seeds. It was further found that the shell of these seeds could be heated or cooked in the presence of moisture without an objectionable color being imparted to the oil. It appeared probable therefore that the domestic crop of castor beans could be processed by single pressing similar to the pressing of the domestic beans in South America. In 1952 one mill on the West Coast pressed castor beans in an Expeller under conditions somewhat similar to that followed in South America. After cleaning, the beans were coarsely ground through a vertical hammermill without screens for breaking of the shell only. No separation of shell from kernel was intended or attempted. The coarsely ground beans were partially cooked and then dried at 200 to 212°F. to reduce the miosture content to 3 to 4%. The beans were then directly pressed in the Expeller, which was equipped with a YJV main worm shaft, rotating at approximately 22 RPM, and a 124-D-1 short vertical shaft. The Expeller could handle 12 tons of beans per 24-hr. day. Shift cake samples for one day averaged 4.02% oil at 5.4% moisture. The oil directly from the Expeller graded as No. 3 oil. However, by adding an absorbant earth or bleaching earth to the oil, warming to approximately 120°F., and then filtering, a No. 1 oil was obtained. On the basis of the work completed at this West Coast mill, it appeared that the wear of the moving parts of the Expeller would be no more severe than when pressing copra.

It appears therefore that the pressing of imported castor beans in an Expeller requires that the imported beans first be decorticated, cooked, and dried. On the other hand, there is evidence that the domestic castor beans may be pressed in an Expeller by simply cracking the shell of the bean without decortication, followed by cooking and drying. It must be borne in mind however that the capacity of an Expeller on decorticated, cooked, and dried castor beans is 25 to 30 tons per day whereas the capacity of the Expeller on non-decorticated beans is approximately 12 tons per day.

The above methods of decortication, cooking, and drying are also applicable to the prepressing of castor beans. If the beans are decorticated, cooked, and dried, they may be prepressed at a rate of 55 to 60 tons of seed per 24-hr. day per Super Duo Expeller. The prepress cake containing 8 to 10% oil may then be granulated, conditioned, and flaked to furnish a durable flake which readily lends itself to the solvent-extraction process. Laboratory and pilot plant tests on the prepress and solvent-extraction steps have indicated that the combined solvent and prepress oil is No. 1 quality oil and that the extracted meal may contain residual oils of less than 1%.

One cannot discuss the processing of castor beans without making some mention of the sensitivity of some individuals to the castor bean. This sensitivity is similar to that experienced by some individuals in the presence of golden rod. Caution must be exercised therefore in screening the personnel to be employed in a castor bean plant. The experience at The V. D. Anderson Company and the information accumulated through correspondence and conversations with those familiar with this allergy, indicate certain procedures may be used to screen personnel for this work. An individual who is allergic to the castor bean develops a congestion of the nasal passages when working with the beans. The eyes and nose tend to become irritated and tend to water. With further exposure the individual coughs, and the congestion in the nasal passages becomes severe. On the other hand, those individuals who are not sensitive to castor beans show very little, if any, reaction. Their eyes may water slightly, but no congestion in the nasal passages occurs. It is possible therefore to test the sensitivity of employees by permitting them to work in the mill for a short period of time. If an employee does not react as described above, he may be considered not allergic to this commodity.

It must be borne in mind any mill operation produces some amount of dust. It is highly desirable in the castor bean operation therefore to provide effective dust control equipment so this source of the allergy-causative agent is kept under control. Mills that have processed castor beans for a number of years report no difficulty with respect to this allergy provided personnel is adequately screened before permanent employment and provided reasonable care is taken with dust control.

[Received November 24, 1953]