Summary and Conclusion
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The present investigation was undertaken to optimize the conditions of extraction and refining of rice bran oil with a view to make it of edible grade. The physico-chemical changes in rice bran oil during extraction, refining, deep fat frying and storage were monitored. The refined rice bran oil was also evaluated as a cooking medium by frying potato chips in oils refined by different methods. The oil absorption and sensory quality of potato chips were also assessed. The storage stability of refined and crude oils was determined at ambient temperature (60°C). The specific findings of the investigation are as follows:

1. The heat stabilized rice bran at 120°C for 45 minutes had 5.4 per cent moisture. The protein, fat, ash, crude fiber and carbohydrates content of rice bran were 14.66, 15.24, 8.75 and 55.95 per cent, respectively.

2. A significantly (P<0.01) higher (82%) oil could be extracted from stabilized rice bran by n-hexane at 60°C in 6 hours using rice bran solvent ratio of 1.5. The higher temperature and time of extraction resulted in a greater loss of solvent.

3. The values of transmittance specific gravity, viscosity, refractive index, smoke point and melting point of crude oil obtained from stabilized rice bran were 8%, 0.931, 47.0 centipoise, 1.469, 212°C and 11.8°C, respectively. The transmittance, specific gravity and viscosity of oil obtained from unstabilized rice bran were 5 per cent, 0.934 and 49.5 centipoise.
4. The saponification value, iodine value, unsaponifiable matter, peroxide value, phospholipids and wax contents of crude rice bran oil obtained from unstabilized rice bran were 186.67, 94.19, 50.90 meq/kg oil, 36.90 (as oleic acid), 18.45 per cent, 3.6, 3.8 per cent and 3.72 per cent. The corresponding values for crude oil obtained from stabilized rice bran were slightly lower except for saponification value and iodine value which were slightly higher.

5. The per cent oil recovered during dewaxing (96.3 and 96.8%) by hot and cold-hot extraction methods, respectively did not differ appreciably. However, the recovery of wax was markedly higher (95.1%) in cold-hot method than hot method (80.5%). The oil content in wax was 5.3 to 5.4 per cent of which 26-27.5 per cent could be extracted from wax by n-haxane. The wax obtained was dark brown in colour with smooth and sticky body, and hard and grilly texture.

6. The maximum recoveries of oil (90.8%) and wax (97.1%) with minimum oil in wax (5.7%) were obtained by dewaxing crude rice bran oil from 60 per cent miscella concentration at 5°C chilling temperature in 10 hours.

7. The dewaxing of rice bran oil reduced its wax content to 0.6 per cent with corresponding decrease in colour intensity to 37 per cent transmittance and melting point to 11°C. The dewaxing of rice bran oil also lowered its viscosity (45.7 centipoise), specific gravity (0.929), peroxide value (39.8 meq/kg oil), acid value (28.6), free fatty acids (14.3%) and unsaponifiable matter(2.87%) as compared to crude oil. However, saponification value of dewaxed oil was higher than crude oil.
8. Among the degumming agents, a mixture of phosphoric acid and water (0.75 % + 3.0 %) was found most effective degumming agent for rice bran oil. Degumming of rice bran oil reduced its phospholipids content from 3.90 to 0.61 per cent. The process of degumming of rice bran oil had no effect on its specific gravity, refractive index, smoke point, acid value and peroxide value. However, colour, intensity, viscosity and saponifiable matter decreased whereas, iodine value and saponification value of degummed rice bran oil increased.

9. The neutralization of degummed rice bran oil by 20 ml of 16 per cent lye gave 65 per cent recovery of oil with 0.22 per cent free fatty acids content in miscella method and 39.75 per cent recovery of oil with 0.98 per cent free fatty acids content in alkali method of refining. Further increase in concentration and volume of lye reduced the recovery of oil drastically whereas, reduction in concentration and volume of lye increased the free fatty acids content of oil significantly (P<0.01). The free fatty acids content of rice bran oil refined by miscella method using 20 ml of 16 per cent lye meets the ISI specifications.

10. Neutralization of rice bran oil caused a slight decrease in its specific gravity, saponification value, iodine value and peroxide value. However, the colour intensity and unsaponifiable matter decreased appreciably. The miscella method of refining gave considerable superior quality refined rice bran oil than alkali neutralization.

11. The bleaching of neutralized rice bran oil with 2 per cent bleaching mixture in the ratio of 5:1 activated bleaching earth and activated charcoal gave best
quality bleached rice bran oil having 92 per cent transmittance of 20 per cent oil in acetone at 570 nm.

12. The bleaching of miscella neutralized oil had little or no effect on specific gravity, refractive index, melting point, acid value, free fatty acid content and phospholipids content of rice bran oil, while saponification value (194.5), smoke point (213°C) and iodine value (99.4) of rice bran oil increased as a result of bleaching. There was an appreciable reduction in colour (94% transmittance) and peroxide value (4.7 meq/kg of oil) of miscella refined rice bran oil after bleaching.

13. The deodourization of rice bran oil slightly decreased its per cent transmittance from 94 to 92 per cent and peroxide from 4.7 to 2.5 meq/kg oil. The specific gravity, viscosity, refractive index, melting point, smoke point, saponification value, acid value, free fatty acids, unsaponifiable matter, phospholipids and wax contents of deodourized rice bran oil were 0.918, 47.5 centipoise, 1.464, 10.5°C, 213°C, 194.0, 0.48, 0.23 %, 0.82%, 0.39% and 0.06%, respectively which remained unaffected by the process of deodourization. The quality of oil thus obtained was in accordance with ISI specification for edible rice bran oil.

14. The most efficient interesterification of miscella refined rice bran oil could be carried out by using 0.2 per cent sodium methoxide as catalyst at 30°C. At 30°C a decreased regioselectivity of fatty acids is obtained which facilitate interesterification.
15. The specific gravity, refractive index and smoke point of miscella refined deodourized and interesterified rice bran oils were the same. However, the viscosity, melting point, peroxide value, acid value and free fatty acids content of interesterified rice bran oil were appreciably higher than miscella refined deodourized oil. The saponification value, iodine value and per cent transmittance of rice bran oil decrease on interesterification.

16. The myristic acid (2.69%), palmetic acid (24.32%) were highest in alkali refined oil. Palmetoleic acid could be detected only in physically refined oil (0.3%) and miscella refined oil (0.2%). The maximum stearic acid was found in interesterified oil. The highest oleic acid, linoleic acid and arachidonic acid contents of miscella refined rice bran were 40.26, 0.63 and 2.92 per cent, respectively. The content of linolenic acid (33.87) was highest in physically refined oil followed by 32.98 per cent in alkali refined oil.

17. The recoveries of oils after frying 50 gms potato chips in 100 gm oil at 180±2°C for miscella, interesterified and alkali refined rice bran oils were 84.5, 83.0 and 82.8 per cent, respectively. The controls, refined groundnut oil and Dhara vegetable oil recoveries were 79.6 and 85.5 per cent, respectively. The absorption of rice bran oils by potato chips ranged between 28.2 to 30.5 percent as compared to 38.5 to 37.5 percent absorption of refined groundnut and Dhara vegetable oils. The rice bran oil fried about 25 per cent more chips.

18. The free fatty acid, peroxide value, viscosity and refractive index of refined rice bran oils as well as control groundnut and Dhara vegetable oils increased,
significantly (P<0.01) due to thermolysis of ester linkage, oxidation of unsaturated fatty acids and polymerization of oxidation products.

19. The sensory scores on 9 point Hedonic scale for potato chips fried in refined groundnut oil and Dhara vegetable oils were significantly (P<0.01) higher than those fried in refined rice bran oil for all the sensory attributes. The sensory scores of potato chips fried in refined rice bran oils for colour and appearance and mouth feel ranged between 5.08 to 6.53 which fall in the range of neither liked nor disliked to liked slightly while the sensory score for taste and flavour and overall acceptability ranged between 6.72 to 6.25 which fall in the range of liked slightly to liked moderately. The potato chips fried in miscella refined rice bran oil had significantly (P<0.01) higher sensory scores for all the attributes followed by those fried in interesterified and alkali refined oils.

20. During storage at 60°C for 120 hours, the physico-chemical characteristics of refined rice bran oils namely thiobarbituric acid (TBA) value, free fatty acids, content peroxide value, colour intensity and rancidity increased significantly (P<0.01). The maximum increase in values of all the physico-chemical characteristics was observed in crude oil. The refined rice bran oils obtained by different methods of refining also differed significantly (P<0.01) with respect to their storage stability. Among all the rice bran oils, miscella refined oil had significantly (P<0.01) superior storage stability.

On the basis of result summarized above, it may be concluded that a good quality rice bran oil could be extracted from stabilized rice bran by n-hexane from rice bran solvent ratio of 1:5 at 60°C in 6 hours. The extracted oil can be
dewaxed by cold-hot method and degummed from 60 per cent oil in miscella at 5°C in 10 hours using 0.75 gm. phosphoric acid and 3 ml. water per 100 gms of oil as degumming agent. The degummed oil may be neutralized by miscella neutralization using 20 ml of 16 per cent lye. The refined oil obtained can be bleached by 2% activated bleaching earth - activated charcoal (5:1) mixture at 110°C and deodourized at 240°C with an absolute pressure 4 mm mercury in 10 minutes by passing steam. The oil thus obtained meets the ISI specifications for edible grade rice bran oil which could be used for cooking and frying purposes. The oil thus will have satisfactory storage stability at room temperature.