TECHNICAL AND CHEMICAL STUDIES ON RICE OIL EXTRACTED FROM LOCAL RICE BRAN

By

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THESIS
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LIST OF ABBRAVIATIONS

AOAC	Association of Official Analytical Chemists
AV	Acid value
FFA	Free Fatty Acid
FAO	Food and Agriculture Organization
RBO	Rice Bran Oil
LDL-C	Low-Density Lipoprotein Cholesterol
PV	Peroxide value
GC	Gas Liquid Chromatography
HDL-C	High-Density Lipoprotein Cholesterol
IP	Induction Period
IUPAC	International Union of Pure and Applied Chemistry
MW	Microwave
OD	Optical density
SFAs	Saturated fatty acids
TBA	Thiobarbituric acid
TC	Total Cholesterol
TSFAs	Total Saturated Fatty Acids
TUSFAs	Total Unsaturated Fatty Acids
UFAs	Unsaturated Fatty Acids
UF	Unsaponifiable fractions
VLDL	Very-Low Density Lipoprotein-Cholesterol
WHO	World Health Organization

5- SUMMARY

Rice bran is the by-product of rice mill process that contains lipase. Rice bran can be used as the raw materials for rice bran oil extraction. Rice bran contains nutritional and antioxidant substances such as tocopherol, vitamin E and gamma oryzanol.

Global interest in the production of edible rice oil for nutrition and medical use at the global level began. Egypt produces large quantities of rice bran that are currently used in the manufacture of animal feed although they contain a percentage of oil that can be used in human nutrition, which works to cover part of the gap existing locally in edible oils between production and consumption as well as its use in medical fields.

In the present investigation, two heat treatment procedures, namely roasting and microwave, were examined to extend the shelf-life of three varieties of rice bran varieties (Giza 178, Sakha 101 and Sakha 104). The present work aims to:

1- Study the effect of heat treatments at different temperatures and different periods to eliminate the high enzymatic activity (Lipase enzyme activity) which leads to non-high percentage of free fatty acids FFA and thus producing a high-quality edible oil.

2- Conduct chemical and technological studies at the local rice bran oil with the study of the effect of storage period on its suitability for human consumption.

The obtained results can be summarized as the following:

1- Physico-chemical properties of rice bran oil (Giza 178, Sakha 101 and Sakha 104) varieties.

a- Physical properties:

Refractive index at 25˚C ± 1 for giza 178, sakha 101 and sakha 104 were 1.4725, 1.4719 and 1.4722, respectively. The rice bran oil (Giza 178, Sakha 101 and Sakha 104 varieties) were their colour measurements which were found 7.5, 8.32 and 7.11, when in the red lovibond scale. In all tested samples the yellow scale is fixed at 35 in a 5.25 inch cell. The colour blue index was also measured were 4.46, 509 and 5.96, respectively.

b- Chemical properties:

The free fatty acids (FFA) %, peroxide value and thiobarbituric acid (TBA) for rice bran oil varieties (Giza 178, Sakha 101 and Sakha 104) were 3.65 %, 8.63 meqO_2/kg and 0.50 mg malonaldehyde/kg; 3.71 %, 8.32 meqO_2/kg and 0.51 mg malonaldehyde/kg and 3.78 %, 8.56 meqO_2/ kg and 0.52 mg malonaldehyde/kg; respectively.

The iodine value for rice bran oil Giza 178 variety was 110.90, this value nearly of the corresponding indices of those found in Sakha 104 variety (110.22). The lowest value of iodine number was observed in Sakha 101 variety, which was found to be as 103.95.

The induction period (IP) of tested sakha 101 was obvious higher than those obtained compared to the other tested samples, which was found to be as 18.84 hours. Meanwhile, it was represented about 13.06, and 12.66 hours for varieties (Giza 178 and Sakha 104), respectively.

The alteration in specific extinction at 232 and 268 nm as the measure of conjugated dienes and trienes fatty acids concentration in the tested samples, it could be observed that the formation extent of conjugated fatty acid dienes was ranged between 2.274 and 2.352 for all investigated samples. Meanwhile, the formation of conjugated fatty acid trienes was ranging from 1.158 and 1.197 for all tested samples.

The unsaponifiable matter content (%) of rice bran oil (giza 178, sakha 101 and sakha 104 varieties) were 4.49, 4.51 and 4.08, respectively.

The rice bran oil sakha 104 variety had the lowest value (191.63) of saponification value, meanwhile the saponification value of giza 178 and sakha 101 varieties were 191.81 and 192.27, respectively.

2- Fatty acids composition (%) of rice bran oil:

Oleic acid (C18:1) and lenoleic acid (C18:2) were predominant fatty acids in rice bran oil varieties (Giza 178, Sakha 101 and 104), which were represented about 39.85 and 38.21 %, 41.56 and 34.60 %, 39.68 and 38.47%, respectively. Moreover, sakha 101 variety had higher percentage of palmitic acid was represented 19.04, compared to the corresponding in giza 178, sakha 104 varieties, which were accounted 17.24 and 17.17%, respectively.

The fatty acid (FA) composition of different rice bran oils. The content of total saturated fatty acids (SFA), myristic (C14:0), palmitic (C16:0), stearic (C18:0) and arachidic (C20:0) acids, in the giza 178, sakha 101 and sakha 104 oils were 19.80, 22.11 and 19.92 % respectively.

The content of linoleic acid (C18:2) in the investigated varieties was 38.21, 34.60 and 38.47% respectively. The content of linolenic acid (C18:3) in giza 178, sakha 101and sakha 104 varieties were found to be 1.59, 1.35 and 1.53 %; respectively.

3- Sterols composition (%) of rice bran oil:

The sterol fractions of Giza 178, Sakha 101 and sakha 104 rice bran oils varieties mainly consisted of campesterol (18.86, 16.82, 17.77%), stigmasterol (21.83, 20.63, 20.98%) and β-sitosterol (39.88, 38.15, 39.00%), respectively.

The total phytosterol (campesterol, stigmasterol and β-sitosterol) in all tested samples was more than 75% of sterol, which was accounted 80.99, 76.06 and 78.20%, respectively.

β-sitosterol was the major of sterols in Giza 178, sakha 101 and sakha 104 rice bran oil varieties which was represented 39.88, 38.15 and 39.00% respectively.

In addition, stigmasterol have a large amount after β-sitosterol in rice bran oil, stigmasterol was found to be as 21.83, 20.63 and 20.98% in varieties (Giza 178, sakha 101 and 104 rice bran oil), respectively.

4- Antioxidant compounds of rice bran oil:-

The antioxidant compounds of giza 178, sakha 101 and sakha 104 rice bran oils mainly consisted of tochopherols mg/100g (54.16, 74.25, 71.66), gamma oryzanol % (0.40, 0.51, 0.52) carotenoids mg/kg (21.95, 36.45, 55.55), chlorophylls mg/kg (39.31, 72.10, 174.55) and antioxidant activity % (54.50, 41.62, 87.00), respectively.

The total antioxidant activity of sakha 104 variety rice bran oil was higher than those found in the other tested samples, which was represented about 87 (%), followed by the sakha 101 rice bran oil which was found to be as 82 (%), while the giza 178 rice bran oil was the lowest content 80 (%).

5-The Effect of different storage periods on FFA (% as oleic acid) of oils extracted from rice bran treated by roasting at different temperature for different periods.

The FFA (% as oleic acid) content was increased gradually in all treatments (90, 100, 110, and 120°C for 5, 10 and 15 min) as increasing the storage period from the initial of storage up to 15 days (end of storage period), but the increasing rate in the FFA% content in rice bran oil was decrease as the heat treatment increased from 90 to 130°C, also with increasing the time of heat treatment from 5 to 15 min, the FFA% content was decrease whereas, the FFA% content at 90°C for 15 min in rice bran oil in all varieties after 15 days of storage period was found ranged from 12.65 to 13.90%, while it was found ranged between 12.13 to 13.10% at 100°C, 11.03 to 12.13% at 110°C, 7.62 to 8.65 at 120°C for 15 min after the same of storage period (15 days), but it was represented from 2.26 to 2.43% at 130°C for 15 min.

The free fatty acids content was significantly increased in all untreated samples, whereas it was increased from 3.71 to 49.75% in average. While at heat treatment at 130°C for 15 min the FFA content in the initial of storage period was 2.34 in average, whereas it was reached to 2.36 at the end of storage period.

6- The Effect of different storage periods on peroxide value (meqO_2/kg) of oils extracted from rice bran treated by roasting at different temperature for different periods.

The peroxide value was high significantly increased in untreated samples from 8.50 meqO_2/kg at the initial of storage to 68.70 meqO_2/kg at the end of storage period (15 days). Meanwhile, the peroxide value in treated samples at 90, 100°C for 5 min was increased in average from 2.05 to 13.43, 1.95 to 13.32 meqO_2/kg, on the other side it was increased in average from 1.99 to 12.65, 1.92 to 12.05 meqO_2/kg in treated samples at 90, 100°C for 10 min, respectively, moreover it was increased from 1.93 to 12.02, 1.88 to 11.50 meqO_2/kg in oil samples extracted from the rice bran treated at 90, 100°C for 15 min from the initial of storage up to the end of storage period; respectively.

Furthermore, when the tested samples treated at 110, 120°C at different period (5,10 and 15 min); the peroxide value in the final product was decrease when compared with that found in the samples treated at 90, 100°C, whereas the peroxide value in average was increased from 1.92 to 12.43, 1.9 to 10.97 meqO_2/kg at 110, 120°C for 5 min, but it was increased from 1.89 to 11.91, 1.87 to 10.43 meqO_2/kg in average at 110, 120°C for 10 min, while it was increased in average from 1.87 to 11.48, 1.85 to 8.89 meqO_2/kg at 110, 120°C for 15 min in oils extracted from all tested rice bran produced from rice varieties.

The peroxide value of the oils extract from rice bran produce from different rice varieties was drastically decrease in all period of storage (8 and 15 days) when treated at 130°C as compared with the same samples treated at 90, 100, 110 and 120°C at the same treatment period (5,10 and 15 min) especially at 15 min of treatment period, meanwhile it was increased from the initial (zero time) and the end of storage (15 days) from in average 1.86 to 5.94 meqO_2/kg (after 5 min), and from in average 1.84 to 4.46 meqO_2/kg (after 10 min), but at 15 min of treatment period at 130°C, the PV was negligible increased from 1.81 to 1.86 meqO_2/kg.

Finally, the best treatment of rice bran before oils extraction was observed at heat treatment for 130°C, also the best of treatment period was exhibited from 15 min. This treatment (130°C at 15 min) for the rice bran produced from all the rice varieties led to approximate completely inhibition of lipase enzyme activity, the evidence for that the free fatty acid content and peroxide value is not increased throughout the storage period till the end of storage.

7- The Effect of different storage periods on FFA (% as oleic acid) and peroxide value (meqO_2/kg) of oils extracted from rice bran after bleaching treated by microwave at different temperature for different periods.

The FFA (% as oleic acid) content was gradually increased in all treatments (high power for 1, 3 and 5 min) as increasing the storage period from the initial of storage up to 15 days (end of storage period), but the increasing rate in the FFA% content in rice bran oil was decrease with increasing the time of heat treatment from 1 to 5 min, whereas, the FFA% content at high power for 1 min in rice bran oil in all varieties after 15 days of storage period was ranged from 12.4 to 12.80%, while it was found ranged between 8.55 to 9.15% at high power for 3 min after the same of storage period (15 days), but it was represented from 2.22 to 2.43% at high power for 5 min.

The peroxide value was sharply increase in untreated samples from 8.50 meqO_2/kg at the initial of storage to 68.70 meqO_2/kg at the end of storage period (15 days). Meanwhile, the peroxide value in treated samples at high power for 1 min was increased in average from 2.84 to 13.17 meqO_2/kg. On the other hand, when the tested samples treated at high power for 3 min; the peroxide value in the final product was decrease when compared with that found in the samples treated at 1 min, whereas the peroxide value in average was increased from 2.67 to 10.26

meqO_2/kg at high power for 3 min in oils extracted from all tested rice bran produced from rice varieties.

That the peroxide value of the oils extract from rice bran produce from different rice varieties was drastically decrease in all period of storage (8 and 15 days) when microwave treated at high power for 5 min as compared with the same samples treated for 1, 3 min, but at 5 min of treatment period at high power, the PV was negligible increased from 2.51 to 2.58 meqO_2/kg.

Finally, the best treatment of rice bran before oils extraction was observed at heat treatment by microwave for 5 min. This treatment (high power at 5 min) for the rice bran produced from all the rice varieties led to approximate completely inhibition of lipase enzyme activity, the evidence for that the peroxide value and free fatty acid is not increased throughout the storage period till the end of storage.

8- Physical and chemical properties of rice bran oil extracted from rice bran variety treated by roasting at 130 ºC for 15 minute.

The free fatty acid (% as Oleic acid) content was decreased in treatment at 130 ºC for 15 min, where decreased from 3.65 to 2.21% for Giza 178 variety , from 3.71 to 2.35% and from 3.78 to 2.39 % for sakha 101 and sakha 104 varieties, respectively. Also peroxide value (meqO_2/kg oil) and thiobarbituric acid (TBA) (mg

malonaldehyde/kg oil) decreased for varieties (Giza 178, sakha 101 and sakha 104), respectively.

The Iodine value was 105.97, 103.46 and 108.78 for both giza 178, sakha 101 and sakha 104, respectively, therefore iodine value decreased by roasting rice bran, where was 110.90, 108.95 and 110.22 for rice bran oil untreated for varieties (Giza 178, sakha 101 and sakha 104), respectively.

The formation extent of conjugated fatty acid dienes, specific extinction at 232 nm, in rice bran oil untreated was 2.274, 2.311 and 2.352 for varieties (Giza 178, sakha 101 and sakha 104), respectively, the conjugated fatty acid dienes was decreased when compared with the rice bran oil treated, where decreased to 1.375, 1.463 and 1.489 nm for varieties (Giza 178, sakha 101 and sakha 104), respectively.

Concerning the influence of heat treatment process on the specific extinction, ultra-violet absorption, at 268 nm as the measure of conjugated fatty acid trienes in tested samples, noticed decreased by heat treatment roasting, where decreased from 1.158 to 0.701, from 1.175 to 0.744 and from 1.197 to 0.757 nm for giza 178, sakha 101 and sakha 104, respectively.

The induction periods (Rancimat; 20 L/h, 110 °C), which is a characteristic of the oxidative stability of the untreated Giza 178, Sakha 101and Sakha 104 varieties rice bran oils were 13.06, 18.84 and 12.66 hr respectively, indicating a high resistance to

oxidation and stability, while samples heat treated (roasting) at 130 °C for 15 minutes was observed that the increased oxidative stability where it was 16.80, 23.00 and 14.50 for varieties (Giza 178, sakha 101 and sakha104), respectively, which shows the increase oxidative stability by heating treatment of the rice bran.

The unsaponifiable matter of the investigated varieties of rice bran oil was 4.49, 4.51 and 4.08% for untreated rice bran, meanwhile, the unsaponifiable matter in treated samples at 130°C for 15 min was increased from 4.49 to 4.85% for giza 178 variety, increased from 4.51 to 4.97, from 4.08 to 4.26% for sakha 101 and sakha 104 varieties, respectively.

The saponification values of rice bran oil untreated giza 178 (191.81 mg KoH/g oil), sakha 101 (192.27 mg KoH/g oil) and sakha 104 (191.63 mg KoH/g oil), on the other hand noticed that the saponification values of heat treatment rice bran oil were 191.17, 192.03 and 191.37 mg KoH/g oil for varieties (Giza 178, sakha 101 and sakha 104), respectively.

9- Physical and chemical properties of rice bran oil extracted from rice bran variety treated by microwave at high power for 5 minute.

The refractive index in rice bran oil treated was 1.4746, 1.4749 and 1.4739 for varieties (Giza 178, Sakha 101 and Sakha 104), respectively.

The colour index of untreated rice bran oil of Giza 178 variety (7.50R, 4.46B), Sakha 101 variety (8.32R, 5.09B) and Sakha 104 variety (7.11R, 5.96B), meanwhile, the unsaponifiable matter in treated samples at high for 5 min was increased (8.20R, 5.85B) for Giza 178 variety, increased (9.08R, 6.40B), (7.95R, 7.68B) for Sakha 101 and Sakha 104 varieties, respectively.

The treatment of rice bran by microwave, could retard the forming of FFA and PV compared with untreated rice bran. The free fatty acid content (% as Oleic acid) content was decreased in treatment at high power for 5 min, where decreased from 3.65 to 2.18% for Giza 178 variety, from 3.71 to 2.24% and from 3.78 to 2.38 % for Sakha 101 and Sakha 104 varieties, respectively .

The peroxide value (meqO_2/kg oil) of the investigated varieties of rice bran oil was 8.63, 8.32 and 8.56 meqO_2/kg for untreated rice bran, meanwhile, the peroxide value in treated samples at high for 5 min was sharply decreased from 8.63 to 2.32 for Giza 178 variety, decreased from 8.32 to 2.55, from 8.56 to 2.66 meqO_2/kg for Sakha 101 and Sakha 104 varieties, respectively. Also decreased thiobarbituric acid (TBA) (mg

malonaldehyde/kg oil) for varieties (Giza 178, Sakha 101 and Sakha 104), respectively.

Iodine value was 108.51, 104.33 and 109.25 for both varieties (Giza 178, sakha 101 and sakha 104), respectively, therefore decreased iodine value by roasting rice bran, where was 110.90, 108.95 and 110.22 for rice bran oil untreated for varieties (Giza 178, sakha 101 and sakha 104), respectively. This is due to increase the proportion of saturated fatty acids.

The formation extent of conjugated fatty acid dienes, specific extinction at 232 nm, in rice bran oil untreated was 2.274, 2.311 and 2.352 for varieties (Giza 178, Sakha 101 and Sakha 104), respectively, the conjugated fatty acid dienes was decreased when compared with the rice bran oil treated, where decreased to 1.357, 1.394 and 1.481 nm for varieties (Giza 178, Sakha 101 and Sakha 104), respectively.

Concerning the influence of heat treatment process on the specific extinction, ultra-violet absorption, at 268 nm as the measure of conjugated fatty acid trienes in tested samples, noticed decreased by heat treatment roasting, where decreased from 1.158 to 0.690, from 1.175 to 0.709 and from 1.197 to 0.754 nm for varieties (Giza 178, Sakha 101 and Sakha 104), respectively.

The induction periods (Rancimat; 20 L/h, 110 °C) of the untreated varieties (Giza 178, Sakha 101and Sakha 104) rice bran oils were 13.06, 18.84 and 12.66 hr respectively, indicating a high

resistance to oxidation and stability, while samples heat treated (microwave) at high for 5 minutes was observed that the increased oxidative stability where it was 18.42, 25.60 and 15.94 for varieties (Giza 178, Sakha 101 and Sakha104), respectively,

The unsaponifiable matter (%) of the investigated varieties of rice bran oil was 4.49, 4.51 and 4.08% for untreated rice bran, meanwhile, the unsaponifiable matter in treated samples at high for 5 min was increased from 4.49 to 5.33% for Giza 178 variety, increased from 4.51 to 5.57, from 4.08 to 5.38% for Sakha 101 and Sakha 104 varieties, respectively.

The saponification values of rice bran oil untreated Giza 178 variety (191.81 mg KoH/g oil), Sakha 101variety (192.27 mg KoH/g oil) and Sakha 104 (191.63 mg KoH/g oil), on the other hand noticed that the saponification values of heat treatment rice bran oil were 191.65, 192.38 and 191.46 mg KoH/g oil for varieties (Giza 178, Sakha 101 and Sakha 104), respectively.

10- Fatty acids composition of rice bran oil extracted from rice bran variety treated by roasting at 130 ºC for 15 minute.

Fatty acids composition of rice bran oil extracted from rice bran variety treated by roasting at 130 ºC for 15 minute. The oil is dominated by the high percentage of polyunsaturated fatty acids (PUFA) than its saturated counterparts. Where it gave relatively high percentage of the important unsaturated fatty acids (oleic

acid 39.46% in treated and 39.85 in untreated) and (linoleic acid 38.06% in treated and 38.21 in untreated), respectively. Major saturated fatty acids present include palmitic acid (17.47% in treated and 17.24% in untreated), stearic acid (1.78% in treated and 1.44% in untreated) and myristic acid (0.25% in treated and 0.34% in untreated) for Giza 178, respectively. While Fatty acids composition for Sakha 101 in Table (43), (oleic acid 41.30% in treated and 41.56 in untreated) and (linoleic acid 34.20% in treated and 34.60 in untreated), respectively. Major saturated fatty acids present include palmitic acid (19.54% in treated and 19.04% in untreated), stearic acid (1.66% in treated and 1.53% in untreated) and myristic acid (0.32% in treated and 0.28% in untreated). On the other hand, fatty acids composition for Sakha 104 (oleic acid 39.26% in treated and 39.68% in untreated) and (linoleic acid 38.27% in treated and 38.47% in untreated), respectively. Major saturated fatty acids present include palmitic acid (17.53 % in treated and 17.17% in untreated), stearic acid (1.89% in treated and 1.59% in untreated) and myristic acid (0.24% in treated and 0.20% in untreated).

11- Fatty acids composition of rice bran oil extracted from rice bran variety treated by microwave at high power for 5 minute.

Fatty acids composition of rice bran oil extracted from rice bran variety treated by microwave at high for 5 minute. The oil is dominated by the high percentage of polyunsaturated fatty acids (PUFA) than its saturated counterparts. Where it gave relatively high percentage of the important unsaturated fatty acids (oleic acid 39.57% in treated and 39.85 in untreated) and (linoleic acid 38.10% in treated and 38.21 in untreated), respectively. Major saturated fatty acids present include palmitic acid (17.62% in treated and 17.24% in untreated), stearic acid (1.65% in treated and 1.44% in untreated) and myristic acid (0.27% in treated and 0.25% in untreated) for Giza 178, respectively. While was Fatty acids composition for Sakha 101 in Table (44), (oleic acid 41.41% in treated and 41.56 in untreated) and (linoleic acid 34.46% in treated and 34.60 in untreated), respectively. Major saturated fatty acids present include palmitic acid (19.55% in treated and 19.04% in untreated), stearic acid (1.66% in treated and 1.53% in untreated) and myristic acid (0.30% in treated and 0.28% in untreated).

On the other hand, was fatty acids composition for Sakha 104 variety (oleic acid 39.47% in treated and 39.68% in untreated) and (linoleic acid 38.36% in treated and 38.47% in untreated), respectively. Major saturated fatty acids present

include palmitic acid (17.75 % in treated and 17.17% in untreated), stearic acid (1.62% in treated and 1.59% in untreated) and myristic acid (0.22% in treated and 0.20% in untreated).

12- Sterols composition of rice bran oil extracted from rice bran variety treated by roasting at 130 ºC for 15 minute.

The β-sitosterol in treated samples at 130°C for 15 min was decreased from 39.88 to 36.69% for Giza 178, decreased from 38.15 to 35.70%, from 39.00 to 36.20% for varieties (Sakha 101 and Sakha 104), respectively, also both campesterols and stigmasterol decreased from 18.86 to 15.24%, from 21.83 to 19.45% for Giza 178 variety, from 16.82 to 14.00%, from 20.63 to 17.80% for Sakha 101 variety and decreased from 17.77 to 13.96%, from 20.98 to 17.11% for Sakha 104 variety, respectively.

The cholesterol composition for Giza 178 variety (0.42% in untreated and 0.30% in treated), for Sakha 101 variety (0.46% in untreated and 0.32% in treated) and for Sakha 104 variety (0.45% in untreated and 0.35% in treated); respectively.

13- Sterols composition of rice bran oil extracted from rice bran variety treated by microwave high power for 5 minute.

The β-sitosterol in treated samples at high power for 5 min was decreased from 39.88 to 38.00% for Giza 178 variety, decreased from 38.15 to 36.98%, from 39.00 to 37.05% for Sakha 101 and Sakha 104 varieties, respectively, also both campesterols and stigmasterol decreased from 18.86 to 16.80%, from 21.83 to

20.11% for Giza 178 variety, from 16.82 to 14.93%, from 20.63 to 18.50% for Sakha 101 variety and decreased from 17.77 to 15.20%, from 20.98 to 18.00% for Sakha 104 variety, respectively.

The cholesterol composition for Giza 178 (0.42% in untreated and 0.35% in treated), for Sakha 101 (0.46% in untreated and 0.38% in treated) and for Sakha 104 (0.45% in untreated and 0.39% in treated), respectively.

14- Antioxidant compounds of rice bran oil extracted from rice bran variety treated by roasting at 130 ºC for 15 minute.

That the tochopherols (mg/100g) of the oils extract from rice bran oil was increased when treated at 130°C as compared with the untreated same samples where it increased from (54.16 in untreated to 56.19 mg/100g in treated), from (74.25 in untreated to 92.24 mg/100g in treated) and from (44.76 in untreated to 63.50 mg/100g in treated) for varieties (Giza 178, Sakha 101 and Sakha 104), respectively. The gamma oryzanol (%) increased from (0.40 in untreated to 0.43% in treated), from (0.51 in untreated to 0.55% in treated) and from (0.47 in untreated to 0.51% in treated) for varieties (Giza 178, Sakha 101 and Sakha 104), respectively.

The antioxidant activity was determined with DPPH free radical scavenging for each fraction of the crude extract of rice bran was in untreated 54.50, 41.62 and 53.12% for varieties (Giza

178, Sakha 101 and Sakha 104), respectively, ratio increased antioxdant activity by heat treatment at 130°C for 15 minutes where it was 72.20, 63.52 and 67.36% for varieties (Giza 178, Sakha 101 and Sakha 104), respectively.

15- Antioxidant compounds of rice bran oil extracted from rice bran variety treated by microwave at high power for 5 minute.

The tochopherols (mg/100g) of the oils extract from rice bran oil was increase when treated at high power as compared with the untreated same samples where it increased from (54.16 in untreated to 57.95 mg/100g in treated), from (74.25 in untreated to 108.35 mg/100g in treated) and from (44.76 in untreated to 71.66 mg/100g in treated) for varieties (Giza 178, Sakha 101 and Sakha 104); respectively.

The gamma oryzanol (%) of the oils extract from rice bran oil was increase when treated at high power as compared with the untreated same samples where it increased from (0.40 in untreated to 0.44% in treated), from (0.51 in untreated to 0.56% in treated) and from (0.47 in untreated to 0.52% in treated) for varieties (Giza 178, Sakha 101 and Sakha 104); respectively.

The antioxidant activity was determined with DPPH free radical scavenging for each fraction of the crude extract of rice bran was in untreated 54.50, 41.62 and 53.12% for varieties (Giza 178, Sakha 101 and Sakha 104); respectively, ratio increased antioxidant activity by heat treatment at high power for 5 minutes

where it was 80.00, 82.70 and 87.00% for varieties (Giza 178, Sakha 101 and Sakha 104), respectively.

16- Effect of different storage periods on free fatty acids (% as oleic acid), peroxide value (meqO_2/kg) and TBA (mg malonaldehyde/kg) of oils extracted from rice bran treated by (roasting and microwave) at different temperature for different periods.

The free fatty acids (% as oleic acid) content was increased gradually in all treatments (130°C for 15 min and microwave at high power for 5 min) as increasing the storage period from the initial of storage up to 4 weeks (end of storage period), but the increasing rate in the FFA% content in rice bran oil was increase as the heat treatment by roasting was high about the increase in the treatment by microwave. The FFA% content at 130°C for 15 min in rice bran oil in all varieties after 4 weeks of storage period was found ranged from 2.21 to 2.51 %, but it was represented from 2.18 to 2.55% at high power for 5 min.

The peroxide value was sharply increase in untreated samples from 8.63 meqO_2/kg at the initial of storage to 105.99 meqO_2/kg at the end of storage period (4 weeks). Meanwhile, the peroxide value in treated samples at 130°C for 15 min was increased in average from 2.51 to 2.73 meqO_2/kg, on the other side it was increased in average from 1.81 to 1.97 meqO_2/kg in treated samples at high power for 5 min, from the initial of storage up to the end of storage period; respectively.

The peroxide value ($meqO_2$/kg) was increased gradually in all treatments (130°C for 15 min and microwave at high power for 5 min) as increasing the storage period from the initial of storage up to 4 weeks (end of storage period), but the increasing rate in the PV in rice bran oil was increase as the heat treatment by roasting was high about the increase in the treatment by microwave. The peroxide value ($meqO_2$/kg) at 130°C for 15 min in rice bran oil in all varieties after 4 weeks of storage period was found ranged from 2.32 to 2.86 ($meqO_2$/kg), but it was represented from 1.90 to 2.01($meqO_2$/kg) at high power for 5 min.

The TBA (mg malonaldehyde/kg) was increased gradually in all treatments (130°C for 15 min and microwave at high power for 5 min) as increasing the storage period from the initial of storage up to 4 weeks (end of storage period), but the increasing rate in the TBA in rice bran oil was increase as the heat treatment by roasting was high about the increase in the treatment by microwave. The TBA at 130°C for 15 min in rice bran oil in all varieties after 4 weeks of storage period was found ranged from 0.30 to 0.33 (mg malonaldehyde/kg), but it was represented from 0.30 to 0.31 (mg malonaldehyde/kg) at high power for 5 min.

TBA (mg malonaldehyde/kg) was sharply increased in all untreated samples, whereas it was increased from 0.51 to 0.70 (mg malonaldehyde/kg) in average. While at heat treatment at 130°C for 15 min and high power for 5 min the TBA in the initial

of storage period was 0.33 and 0.32 (mg malonaldehyde/kg) in average, whereas it was reached to 0.32 and 0.31 (mg malonaldehyde/kg) at the end of storage period, respectively.

Conclusion and recommendation of this investigation

Rice bran is a by-product of rice milling industry and constitutes around 10% of the total weight of rough rice. It is a rich source of vitamins, minerals, essential fatty acids, dietary fiber and other sterols. There is a widespread scientific agreement on various health benefits associated with consumption of dietary fiber. Consumer attitude towards health foods is promising and the scope of functional foods is growing in the world markets; rice bran is finding increased applications in food, pharmaceutical industries. However, potential applications of rice bran in food industry are limited by its in stability owing to rancidity caused by exposure of oil to lipases during milling. Various methods of stabilization have been carried out, paving way for supplementation of rice bran in numerous food preparations.

Small portion of rice bran is processed into edible oil. Rancidity of lipids in RBO is a major problem for utilization of rice bran. The high lipid content and a potent enzymes result in drastic quality reduction of rice bran. Storage of rice bran, especially at room temperature, for extended periods leads to degradation of triglycerides in the oil and ultimately to the formation of off- flavors and odors. Rice bran contains active enzymes. Germ and outer layers of the caryopsis have higher enzyme activities. Particular lipase, but also lipoxygenase and peroxidase, are probably most important commercially because they affect the keeping quality and shelf life of rice bran

In this investigation it was shown that rice bran stabilization by using heat or microwave treatments were able to significantly suppress an increase of FFA content and peroxide value of stabilized rice as compared to untreated rice bran. Particularly, at 130ºC for 15 min. of heat treatment, as well as

the microwave treatment at high power for 5 min. was the best treatment for preventing rancidity (FFA content and peroxide value of the oil extracted from rice bran) with a minimum decrease in α-tocopherol and γ-oryzanol contents and the other beneficial compounds.

It could be recommended that the heat source or microwave magnetron unit can be used in combination with the small or medium rice milling unit to produce rice bran with the better self-life by inactivation the lipase and lipoxygenase enzymes which causing the rice bran oil deterioration. Meanwhile, the obtained of edible rice bran oil without any problem when the oil extraction from the rice bran, and thus the nutrition contents in rice bran oil can be preserved.