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# Physicochemical Characterization of Rice (*Oryza sativa*) Bran Oil from Some Egyptian Rice Varieties

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## ABSTRACT

In view of growing demand on vegetable oils in Egypt. Find a new edible oil sources from non-traditional oil crops has a great interest. The present investigation was aimed to characterize rice bran oil from three Egyptian rice varieties, namely Sakha 106, Giza 178 and Egyptian Yasmine. The crude oil content ranged from15.75 to 21.42%. Physicochemical parameters of the hexane-extracted crude rice bran oils were found to be as follow: specific gravity (30ºC) (0.8163 - 0.8590), photometric colour index (2.6- 3.96), moisture and volatile matters contents (1.90 - 6.92), saponification value (172.01- 181.21 mg KOH/g), acid value (3.80 - 5.59 mg of KOH/g), free fatty acids% (1.9 - 2.81 %), ester value (168.20- 175.41 mg of KOH/g), peroxide value (0.99 - 5.55 meq/Kg), p-anisidine value (5.90 - 13.63) and totox value (15.10 - 22.90). Furthermore rice bran oil of selected varieties possesses simple fatty acid profile with three fatty acids namely oleic, palmitic and linoleic acids present more than 90% of the fatty acids. Also, rice bran oil of selected varieties was found to contain unsaponifiable matter 3.35 - 4.57%, wax 3.00 - 3.41% and gamma- oryzanol 1.59 - 3.65 gm/100 gm oil. In general, rice bran oil has several physiochemical, compositional and nutritional properties similar to those of traditional vegetable oils; which allow using rice bran oil as an important ingredient of human diet. In addition, the high level of natural antioxidants especially gamma- oryzanol improves the oxidative stability of rice bran oil.


**Keywords** : Sakha 106, Giza 178, Egyptian Yasmine, Rice bran oil, gamma- oryzanol

## INTRODUCTION

Rice (*Oryza sativa*) is the second main cereal crop and staple nourishment of half of the total populace in terms of global production 740.96 million tonnes of rough rice in 2014 (FAO/UN, 2016). In 2014, the production of rice in Egypt was 6.00 million tons. Egypt recorded the second yield in the world (3.86 tonnes/Ac) per year during the years 2010–2014 (FAO/UN, 2016).

Rice bran is the main by product from rice processing industry. During the whiting process, which applies friction to the grain surface, the bran is removed from the kernel and usually accounts for about 10% of raw rice weight (Bhatnagar *et al*. 2014). The biggest limitation to the utilization of rice bran as a food ingredient, or even as a source of edible oil, is its naturally occurring enzymatic activity which includes lipase, lipoxygenase and peroxidase. In addition to endogenous enzymes, microbial enzymes also cause oxidative deterioration of rice bran (Orthoefer, 2005). Therefore Stabilization of the bran soon after milling is thus very important. Less than 10 % of global rice bran production (60-72 million metric tons yearly) is stabilized, while over 90% is sold as animal feed (Kahlon and Smith 2004). Extraction of crude rice bran oil should be done within a few hours of milling to avoid high free fatty acids content (Ju and Vali, 2005).

Rice bran contains approximately 20 % lipid, with a range from 15% to 25% (Sugano and Tsuji, 1997). Rice bran oil is a standout amongst the most healthy and nutritious edible oils. The fatty acid profile of rice bran oil reveals approximately 19% saturated (palmitic acid), 42% monounsaturated (oleic acid) and 39% polyunsaturated (linoleic acid) (Mezouari. *et al.,* 2006). Crude rice bran oil is reported for its untraditional elevated content of unsaponifiable matter comparing with other vegetable oils. Refined rice bran oil and crude rice bran oil may contain 1.5-2.6% and 5%of unsaponifiable matter, respectively, while the unsaponifiable content of many common oilseed oils is normally only 0.4- 0.6% (Rong *et al.*, 1997).

One of the bioactive nutraceuticals found at elevated concentration in rice bran oil is γ- oryzanol. Nearly 1.7-2.1% of gamma oryzanol is present in crude rice bran oil (Patel and Naik, 2004). Various physiological and biological properties have been associated with γ-oryzanol, such as antioxidant properties and cholesterol lowering capacity (Wang *et al.*, 2014). Gamma -oryzanol combine the health-promoting effects of phytosterols and ferulic acid. Mammalian digestive steryl esterases cleave the ester bond between ferulic acid and phytosterol, liberating the cholesterol-lowering phytosterol moiety and antioxidative ferulic acid moiety (Mandak and Nyström, 2012).

The estimated production of rice bran oil in Egypt can be worked out to be 150 thousand tons produced from 6 million tons rice annually. This will enhance decreasing the gap between demand and availability of local edible oils (FAO/UN, 2016). So, the present investigation was designed for the analytical characterization of crude rice bran oil from three Egyptian rice varieties, namely Sakha 106, Giza 178 and Egyptian Yasmine.

## MATERIALS AND METHODS

**Materials:**

Three authenticated rice varieties namely, Sakha 106, Giza 178 and Egyptian Yasmine were collected from Rice Research and Training Center (RRTC) at Sakha, Kafrelsheikh, Egypt. Rice samples were harvested during crop season 2014 from RRTC. All the solvents and chemicals used in the present study were of analytical grade and obtained from SDFCL S D Fine-Chem Limited, India.

**Preparation of rice bran:**

Rice samples of Sakha 106, Giza 178 and Egyptian Yasmine varieties were dehusked using a laboratory to obtain brown rice then, brown rice was milled using satake rice machine, style TM05 TEST MILL Satake company., Hiroshima, Japan to about 10 percentage degree of milling. All the bran samples were sifted through a 20 mesh size screen to separate broken husks and pieces of rice, then it was stabilized, thin layer of freshly milled rice bran (less than 0.5 mm in height) was heated on the pre-heated aluminum tray in a hot air stove at 110 ºC for ten min. Bran samples were stored in dark condition at -10°C in water insusceptible containers.

**Rice bran analysis:**

The moisture content of the rice bran samples was analyzed by hot-air stove method according to AOAC (2005). The crude fat content of each sample was estimated using Soxhlet method according to AACC, (2000).

**Extraction of crude rice bran oil:**

Crude rice bran oil was extracted from stabilized rice bran samples (50 g) by soxhlet apparatus for 4 h using hexane.

**Physicochemical properties of rice bran oil:**

The Specific Gravity of crude rice bran oil samples was analyzed at 30ºC as indicated by the methods of AOCS, (1998). The photometric color index (PCI) was assessed as indicated by the method mentioned by Pike (2003).

The moisture and volatile matters content was determined according to Ghatak and Panchal, (2010). Acid, Saponification, Peroxide value and unsaponifiable matter were determined according to the methods described in AOCS, (1998).

Wax content in rice bran oil was assessed in terms of acetone indissoluble as indicated by Manjula and Subramanian, (2009).

Fatty acids composition of crude rice bran oil was determined by trans esterification with 2% methanolic sulphuric acid followed by GC of the fatty acids methyl esters (IUPAC, 1987). The analysis was finished on a Shimadzu Gas Chromatograph Model 14–A (Shimadzu Co., Japan) equipped with a flame ionization detector and a cross-linked capillary column, model number: Agilent US4670511H (60 m x 0.32 mm i.d., film thickness = 0.25µm).

TBARS were analyzed as indicated by the method of Shahidi *et al.* (2003). Aldehydes (mainly 2-alkenals) occurred in oil are quantified by determination p-anisidine value, which was determined using the method of IUPAC. (1987). Total Totox value is an indicator of the total oxidation (Che Man and Hussin, 1998), and is calculated as indicated by the following formula:

**Totox value = (2 × Peroxide value ) + p-Anisidine value**

γ-Oryzanol content of rice bran oil samples was determined spectrophoto-metrically by using molar extinction coefficient of oryzanol 359 $M^{-1}$ $cm^{-1}$ (IICT, 2008). Briefly, 20 mg of the oil sample was accurately weighed into 25 ml volumetric flask and then made up to the mark with n-heptane, mixed thoroughly and absorbance was measured at 315 nm using in Labomed UV-2602 spectrophotometer (Los Angeles, CA 90034 U.S.A). n-Heptane was used as blank. Gamma oryzanol content was calculated as follows:

**Gamma oryzanol content (g/100 g) = (25 ×A315)/ (W×E)**

**Where** W = mass of sample (g)

$A_{315}$ = extinction (absorbance) of the solution already corrected based on reagent blank

E (specific extinction $^{E1\%}$ l cm) = 359

**Statistical analysis:**

Statistical analysis (ANOVA) was employed by SPSS (2013) Version22 program for windows.

## RESULTS AND DISCUSSION

The moisture and crude oil content of crude rice bran from the selected varieties are presented in Table (1). Results indicate that the values for moisture content in selected rice bran samples were significantly different (P< 0.05). Giza 178 bran has the highest moisture content (8.41%). It could also be seen from Table (1) that the crude oil content ranged from15.75 to 21.42%. This was comparable to that reported by Monsoor *et al.* (2003), who found that rice bran contained 12.8 to 22.6% fat. The Japonica and indica/japonica varieties (Sakha 106 and Giza 178 respectively) have significantly higher levels (P< 0.05) of crude oil content than those of Indica variety (Egyptian Yasmine) (Table 1). Significant varietal effect on crude oil content of rice bran as observed here is also reported by, Goffman *et al*. (2003) who investigated the crude oil content of 204 rice varieties. They mentioned that the genotype and environment (year) significantly affected oil content which extended from 17.0 to 27.5%. The percentage of oil content in general differs with the different varieties of rice bran and might be attributed to geographical location, soil texture, fertilizer treatment, environmental influences, milling techniques and pre-treatment like parboiling, sheller and huller milling (Orthoefer, 2005).

**Table 1. Moisture and crude oil content of rice bran from some Egyptian rice varieties (dry weight basis) *.**

| Rice variety | Moisture content % | Crude oil Content % |
|---|---|---|
| Sakha 106 | $4.70^{a}$ ±0.23 | $20.40^{b}$ ±0.38 |
| Giza 178 | $8.41^{c}$ ±0.26 | $21.42^{b}$ ±0.93 |
| Egyptian Yasmine | $6.59^{b}$ ±0.32 | $15.75^{a}$ ±0.26 |

***Values are means of three replicates ± standard deviation.**

**$^{a-c}$ Values in the same column with the same letter are not significantly different at P ≤ 0.05.**

**Physicochemical characteristics of rice bran oil**

The crude rice bran oil was extracted from the selected varieties and analyzed for various physicochemical parameters. The results presented in Table (2) indicate that the physicochemical characteristics of crude rice bran oil for varieties varied in middling range. The specific gravity of rice bran oil samples ranged from 0.8163 to 0.8590. These results are generally agreed with those recorded by Rossell, (1991), which was 0.850 to 0.950. The specific gravity values of Japonica and indica/japonica varieties (Sakha 106 and Giza 178 respectively) were significantly higher (P< 0.05) than that of Indica variety (Egyptian Yasmine). Nearly the same trend was obtained by Anwar *et al.*, (2005). Specific gravity of the crude oil of four varieties of rice bran viz. Super Kernel, 386, 385 and Basmati, was 0 .919, 0.913, 0 .910 and 0.909, respectively. Generally, either unsaturation degree of the fatty acid chains increase or increase in chain length of the fatty acids tend to increase the specific gravity (Iqbal and Mido, 2005).

Photometric colour index values of crude rice bran oil samples were significantly different at $P< 0.05$. The crude rice bran oil of variety Egyptian Yasmine was superior in colour index (2.60), while Sakha 106 variety was significantly found with highest ($P< 0.05$) colour index (3.96) followed by Giza 178 (3.40). Oil colour is one of the primary variables in analyzing the quality of edible oils. Crude rice bran oil colour is mainly influenced by quality of bran, processing methods, storage conditions and method of extraction, and highly improved after refining process (Arumughan *et al*., 2003).

The values of moisture and volatile matters contents of crude rice bran oil samples were significantly different at $P< 0.05$ and ranged from 1.90 to 6.92. In general oils can contain water and volatile compounds as a result of the extraction method. The presence of water in crude rice bran oil promote triacylglycerol hydrolysis to glycerol and FFAs, but under practical conditions, the rate of Hydrolysis of triacylglycerol molecule to produce FFA is negligible at 0.5 - 1.0 % moisture content (Sanghi and Tiwle, 2015) .

Saponification value reflects the average molecular weight of the fatty acids existing in oil. The oil with low average molecular weight of fatty acids has a higher saponification value. The obtained results (Table 2) indicated that saponification value of crude rice bran oil samples were ranged from 172.01- 181.21 mg KOH/g. The saponification value of Sakha 106 and Giza 178 crude rice bran oils were significantly equal at $P< 0.05$ and also were in close agreement with those reported in the literature which was 180-195 mg KOH/g While the saponification value of Egyptian Yasmine crude rice bran oil was lower (172.01 mg KOH/g) (Orthoefer, 2005). These values were lower than those found by Ghatak and Panchal, (2010), they found the saponification value of crude rice bran oil was 193.54 mg KOH/g.

The acid values and free fatty acids percent of crude rice bran oil samples were significantly different at $P< 0.05$ and ranged from 3.80 to 5.59 mg of KOH/g of oil and 1.9 to 2.81 % respectively. These free fatty acids content are ideal compared with the specifications established by the food safety and standards authority of India for crude rice bran oil, which must be lower than 10% (Sanghi and Tiwle, 2015). Acid value reflects the degree of oil hydrolysis and the amount of FFAs in the sample. Higher values indicate undesirable changes as it not only results in greater refining losses but also increases susceptibility of oils to rancidity. Previously, it has been reported that rice bran with an excess of 5% and crude rice bran oil with excess of 10% free fatty acids are considered unsuitable for human utilization (Ramezanzadeh *et al*., 1999).

Peroxide values of crude rice bran oil samples were significantly different at $P< 0.05$ and ranged from 0.99 to 5.55 meq/Kg. The peroxide values of the three crude rice bran oil samples are close to the recommended value since, it has been reported that peroxide values of freshly extracted oils should be below 10 meq/kg and that the taste of rancid oil appeared clearly when peroxide values were between 20 - 40 meq/kg (AOAC, 2000). Similar trend has been registered by Al-Okbi *et al.,* (2014), who reported a range from 3.0 to 4.5 meq/kg for crude rice bran oil was extracted by n-hexane and by supercritical $CO_2$ extraction while lower peroxide values ranged from 1.50- 3.00 meq/kg of crude rice bran oil was observed by Anwar *et al*., (2005). The high value of PV for Sakha 106 crude rice bran oil could be attributed to a significantly higher level of C18:2 which is more prone to oxidation than C18:1. The p-anisidine values of crude rice bran oil samples were significantly different at $P< 0.05$ and ranged from 5.90 to 13.63. The obtained results (Table 2) indicate that Sakha 106 crude rice bran oil had the lowest ($P< 0.05$) p-anisidine value; this could be attributed to a significantly too high content of gamma-oryzanol which acts as antioxidant. P-Anisidine value ranged from 2.94 to 4.00 for crude rice bran oil as reported by Anwar *et al*., (2005).The values for totox value of crude rice bran oil samples were significantly different at $P< 0.05$ and ranged from 15.10 to 22.90. The thiobarbituric acid test was used to detect the oxidative deterioration. During autoxidation malonaldehyde is presented as a result of the degradation of primary oxidative products (Cesa, 2004). The obtained results (Table 2) indicated that the values for TBARS of crude rice bran oil samples were significantly equal at $P< 0.05$. Looking at lipid oxidation parameters, it can be concluded that the crude rice bran oils from the selected varieties exhibited a high oxidative stability.

**Table 2. Physicochemical properties of crude rice bran oil from some Egyptian rice varieties (dry weight basis)*.**

| Parameters | Rice varieties | | |
|---|---|---|---|
| | Sakha 106 | Giza 178 | Egyptian Yasmine |
| Specific Gravity | $0.8555^b$ ±0.0040 | $0.8590^b$ ±0.0003 | $0.8163^a$ ±0.0009 |
| Photometric colour index | $3.96^c$ ±0.27 | $3.40^b$ ±0.31 | $2.60^a$ ±0.14 |
| Moisture and volatile matter % | $3.44^b$ ±0.09 | $1.90^a$ ±0.02 | $6.92^c$ ±0.22 |
| Saponification value (mg of KOH/g of oil) | $181.00^b$ ±0.31 | $181.21^b$ ±0.36 | $172.01^a$ ±0.83 |
| Acid Value (mg of KOH/g of oil) | $5.59^c$ ±0.09 | $5.40^b$ ±0.02 | $3.80^a$ ±0.02 |
| FFA as % oleic acid | $2.81^c$ ±0.05 | $2.71^b$ ±0.01 | $1.91^a$ ±0.01 |
| Ester value | $175.41^b$ ±0.22 | $175.81^b$ ±0.38 | $168.20^a$ ±0.81 |
| Peroxide value (meq $O_2 \cdot kg^{-1}$ oil) | $5.5515^c$ ±0.1201 | $0.9874^a$ ±0.0111 | $4.6350^b$ ±0.1032 |
| *p*-anisidine Value | $5.8967^a$ ±0.0758 | $13.1205^b$ ±0.2448 | $13.6321^c$ ±0.1475 |
| Totox value | $16.9998^b$ ±0.1799 | $15.0954^a$ ±0.2277 | $22.9021^c$ ±0.0596 |
| TBARS[1] (μmol malonaldehyde equivalents/g oil) | $0.0393^a$ ±0.0073 | $0.0414^a$ ±0.0079 | $0.0312^a$ ±0.0077 |

***Values are means of three replicates ± standard deviation.**
**[1]TBARS : Thiobarbituric acid reactive substances**
**[a-c] Values in the same row with the same letter are not significantly different at P ≤ 0.05.**

## Fatty acids composition of rice bran oil

The fatty acids composition (Table 3) show that oleic acid (C18:1) was the predominant fatty acid followed by linoleic (C18:2) and palmitic (C16:0) acid, which were in the ranges of 39.60- 41.78, 31.24- 37.88 and 17.04- 19.64%, respectively. Myristic (C14:0), Stearic (C18:0), Arachidic (C20:0), Palmitoleic (C16:1) and Linolenic (C 18:3 ω−3 ) were also detected but in low concentrations. Thus, rice bran oil possesses simple fatty acid profile with three fatty acids oleic, palmitic and linoleic acids constitute more than 90% of the fatty acids present with saturated to unsaturated ratio 1:3.5 and oleic to linoleic acid ratio of approximately 1 : 1.17. The concentration of major fatty acids, C18:2, C18:1, C16:0 of the investigated rice bran oils was generally agreed with those obtained by Goffman *et al*., (2003), who studied the fatty acid composition of 204 rice varieties and found that the main fatty acids in rice bran oil were palmitic, oleic, and linoleic acids, which were in the ranges of 13.9–22.1, 35.9–49.2, and 27.3– 41.0%, respectively. Varietal variations for fatty acid composition was significant at P< 0.05 with regard to of palmitic (C16:0) acid, oleic acid (C18:1) and linoleic (C18:2). The Indica and indica / japonica varieties (Egyptian Yasmine and Giza 178 respectively) have significantly higher content (P< 0.05) of palmitic and oleic acid than that of Japonica variety (Sakha 106). While Sakha 106 variety has significantly found with highest (P< 0.05) linoleic content (37.88%) followed by Giza 178 (33.35%). Same trend was observed by Goffman *et al*., (2003) who found that the palmitic acid content ranged from 14.9 to 17.2% in Japonica and from 19.3 to 20.4% in Indica varieties. The fatty acid profile of rice bran oil is nearly comparable to that of peanut oil, but slightly higher in saturation level than that of soybean oil. Therefore rice bran oil is closely suitable for general frying and cooking applications (McCaskill and Zhang, 1999).

**Table 3. Fatty acids composition (weight %) of rice bran oil from some Egyptian rice varieties*.**

| Fatty acid | Rice varieties | | |
|---|---|---|---|
| | Sakha 106 | Giza 178 | Egyptian Yasmine |
| Myristic (C14:0) | $0.375^{a}$ ±0.078 | $0.460^{a}$ ±0.042 | $0.565^{a}$ ±0.064 |
| Palmitic (C16:0) | $17.040^{a}$ ±0.141 | $19.240^{b}$ ±0.339 | $19.635^{b}$ ±0.530 |
| Heptadecanoic (C17:0) | $0.045^{a}$ ±0.007 | $0.700^{b}$ ±0.141 | $0.160^{a}$ ±0.028 |
| Stearic (C18:0) | $1.800^{a}$ ±0.339 | $1.605^{a}$ ±0.035 | $2.480^{a}$ ±0.509 |
| Arachidic (C20:0) | $0.705^{a}$ ±0.035 | $0.570^{a}$ ±0.057 | $0.745^{a}$ ±0.191 |
| Palmitoleic (C16:1) | $0.400^{a}$ ±0.071 | $0.325^{a}$ ±0.035 | $0.510^{a}$ ±0.113 |
| Heptadecenoic (C17:1) | $0.135^{a}$ ±0.021 | $0.340^{b}$ ±0.057 | $0.070^{a}$ ±0.014 |
| Oleic (C18:1) | $39.600^{a}$ ±0.523 | $41.055^{b}$ ±0.007 | $41.775^{b}$ ±0.304 |
| Eicosenoic (C20:1) | $0.660^{ab}$ ±0.014 | $0.425^{a}$ ±0.120 | $1.034^{b}$ ±0.288 |
| Linoleic (C18:2) | $37.875^{c}$ ±0.205 | $33.350^{b}$ ±0.339 | $31.235^{a}$ ±0.389 |
| Linolenic(C18:3 ω−3 ) | $1.425^{a}$ ±0.007 | $2.195^{a}$ ±0.049 | $1.930^{a}$ ±0.735 |
| Saturated (SFA) | $19.965^{a}$ ±0.516 | $22.575^{b}$ ±0.332 | $23.585^{b}$ ±0.304 |
| Unsaturated (MUFA+ PUFA) fatty acid | $80.095^{b}$ ±0.643 | $77.690^{a}$ ±0.297 | $76.555^{a}$ ±0.120 |

***Values are means of three replicates ± standard deviation.**
**a-c Values in the same row with the same letter are not significantly different at P ≤ 0.05.**

**Unsaponifiable matter and wax content of rice bran oil**

The results in Table (4) show that unsaponifiable matter and wax content of crude rice bran oil samples were ranged from 3.35 to 4.57 and 3.00 to 3.41% respectively. The results of unsaponifiable matter and wax content were in accordance with those reported by Orthoefer, (2005), who reported 3–5% and from less than 1% to more than 4%, for unsaponifiable matter and wax content respectively. These values were lower than those found by Anwar *et al*., (2005), who reported that the range of unsaponifiable matter of four varieties of rice bran oil were 4.98- 6.15%.

**Table 4. Unsaponifiable Matter and wax content of rice bran oil from some Egyptian rice varieties (dry weight basis) *.**

| Rice varieties | Unsaponifiable Matter % | Wax content % |
|---|---|---|
| Sakha 106 | $4.57^{b}$ ±0.07 | $3.41^{a}$ ±0.51 |
| Giza 178 | $3.35^{a}$ ±0.08 | $3.25^{a}$ ±0.25 |
| Egyptian Yasmine | $3.55^{a}$ ±0.09 | $3.00^{a}$ ±0.12 |

***Values are means of three replicates ± standard deviation.**
**a-c Values in the same column with the same letter are not significantly different at P ≤ 0.05.**

The Japonica variety (Sakha 106) has significantly higher content (P< 0.05) of unsaponifiable matter than that of Indica and indica/japonica varieties (Egyptian Yasmine and Giza 178 respectively). Crude rice bran oil is noted for its remarkably high content of unsaponifiable matter comparing with vegetable oils. Refined rice bran oil may contain 1.5-2.6% of unsaponifiable matter and Crude rice bran oil may contain up to 5% of unsaponifiable matter, while The unsaponifiable content of many common oilseed oils is normally only 0.4- 0.6% (Rong *et al*., 1997).

**Occurrence of gamma-oryzanol in rice bran, crude rice bran oil and unsaponifiable matter**

It can be observed from Table (5) that gamma-oryzanol content of unsaponifiable matter, crude rice bran oil and rice bran from the selected varieties ranged from 44.51 to 80.60 gm/100 gm unsaponifiable matter, 1.59 to 3.65 gm/100 gm oil and 0.232 to 0.719 gm/100 gm bran, respectively. Concerning gamma-oryzanol contents of selected varieties, significant difference (P< 0.05) between varieties was found. The maximum level of γ-oryzanol was presented in Sakha 106 crude rice bran oil (3.65 gm/100 gm oil). It was higher than that reported (1.7-2.1%) by Patel and Naik, (2004); Sanghi and Tiwle, (2015), while the γ-oryzanol content of other varieties crude rice bran oil were generally agreed with those obtained by Gopala krishna *et al*., (2001). They investigated the gamma- oryzanol content of bran oil from 18 Indian rice varieties which ranged from 1.63 to 2.72%. Rice bran from a conventional US long grain rice variety and Bengal have been shown to contain γ-oryzanol ranging from 0.34 to 0.42 gm/100 gm rice bran which varies according to the extraction methods and the extraction solvents (Chen and Bergman, 2005).

**Table 5. Distribution of γ-oryzanol among unsaponifiable matter, rice bran oil and rice bran from some Egyptian rice varieties on dry weight basis *.**

| Rice varieties | γ oryzanol (gm/100 gm oil) | γ oryzanol (gm/100 gm bran) | γ oryzanol (gm/100 gm Unsaponifiable Matter) |
|---|---|---|---|
| Sakha 106 | 3.648[c] ±0.013 | 0.719[c] ±0.015 | 80.607[b] ±1.312 |
| Giza 178 | 1.850[b] ±0.005 | 0.389[b] ±0.017 | 55.278[a] ±1.061 |
| Egyptian Yasmine | 1.585[a] ±0.012 | 0.232[a] ±0.003 | 44.512[a] ±1.502 |

***Values are means of three replicates ± standard deviation.**
**[a-c] Values in the same column with the same letter are not significantly different at $P \leq 0.05$.**

In conclusion, 150 thousand tons of edible rice bran oil can be produced in Egypt. The rice bran from the selected varieties contain high amount of crude oil. Rice bran oil from the selected varieties exhibited a high oxidative stability and has excellent fatty acids profile, Therefore rice bran oil is closely suitable for general frying and cooking applications. The level of gamma-oryzanol and unsaponifiable matter in Sakha 106 crude rice bran oil was higher than that reported by other authors. Therefore, It can be used as a good source for phytochemicals particularly γ- oryzanol.

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## الخواص الطبيعية والكيماوية لزيت رجيع الكون المستخلص من بعض أصناف الأرز المصرية

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نظرا لزيادة الطلب على الزيوت النباتية مع انخفاض المنتج محليا منها، فقد أصبح من المقتضيات الضرورية البحث عن مصادر غير تقليدية للزيوت الغذائية بخلاف زيوت المحاصيل الزيتية . جاءت هذة الدراسة لتواكب هذا التحدي، حيث تهدف إلى توصيف الخواص الطبيعية والكيماوية لزيت رجيع الكون المستخلص من رجيع ثلاثة أصناف أرز مصرية تشمل سخا ١٠٦ و جيزة ١٧٨ وياسمين المصري. أوضحت النتائج أن رجيع الكون الناتج من أصناف الأرز تحت الدراسة يحتوي على زيت خام يتراوح من ١٥.٧٥ إلي ٢١.٤٢% . أظهرت نتائج التحاليل الفيزوكيمائية للزيوت المستخلصة أن الوزن النوعي يتراوح من ٠.٨١٦٣ الي ٠.٨٥٩٠ ، معامل اللون من ٢.٦ إلى ٣.٩٦ ، المحتوي الرطوبي والمواد المتطايرة من ١.٩ إلى ٦.٩٢ ، رقم التصبن من ١٧٢.٠١ إلى ١٨١.٢١ ملجم هيدروكسيد بوتاسيوم / جم ، ورقم الحموضة من ٣.٨ إلى ٥.٥٩ ملجم هيدروكسيد بوتاسيوم / جم ،النسبة المئوية للأحماض الدهنية الحرة من ١.٩ إلى ٢.٨١ % ، رقم الأستر من ١٦٨.٢ الى ١٧٥.٤١ ملجم هيدروكسيد بوتاسيوم / جم ، رقم البيروكسيد من ٠.٩٩ إلى ٥.٥٥ ملي مكافئ / كجم ، ورقم البارانسيدين من ٥.٩٠ الى ١٣.٦٣ ورقم التوتكس من ١٥.١ إلي ٢٢.٩. كما أظهرت نتائج التحليل الكروماتوجرافي أن محتوى زيت رجيع الكون من حمض البالمتيك والأوليك واللينوليك مجتمعة أكثر من ٩٠% من مجموع الأحماض الدهنية. كما أظهرت النتائج احتواء زيت رجيع الكون على نسبة عالية من المواد غير القابلة للتصبن تتراوح من ٣.٣٥ إلى ٤.٥٧، كما تحتوي على شموع بنسبة تتراوح من ٣.٠٠ إلي ٣.٤١ % ، وجاما أوريزانول بنسبة تتراوح من ١.٥٩ % إلي ٣.٦٥% . تفيد النتائج السابقة أن خواص زيت رجيع الكون مشابهة الى حد كبير لخواص الزيوت النباتية التقليدية، مما يسمح باستخدامها كزيت غذائي ملائم لكافة الأغراض. كما أن احتواء زيت رجيع الكون الخام على نسبة عالية من مضادات الأكسدة الطبيعية خاصة الجاما أوريزانول يمثل ميزة تغذوية ويجعله أكثر ثباتا ضد حدوث التزنخ التأكسدي.

**الكلمات الدالة :** زيت رجيع الكون - سخا ١٠٦ - جيزة ١٧٨ - ياسمين المصري - الجاما أوريزانول