4. RESULTS AND DISCUSSION

4.1. Chemical composition of rice bran, barley radicle and biscuits:

Chemical composition of raw materials and biscuits manufactured are tabulated in Table (8). The composition of rice bran depends on a variety of factors associated with the rice grain itself and the milling process.

The obtained results indicated that rice bran and radicle from barley are rich in protein, it amounted to 16.50% and 22.24%, respectively. While rice bran shows that the total lipids was 17.68% which higher than of radicle (2.82%).

From the obtained results, it could be noticed that the rice bran components (on dry weight basis) were 11.18, 7.20, 7.81 and 50.81% of moisture, ash, crude fiber and total carbohydrates, respectively.

On the other hand, radicle from barley shows that values of moisture, ash, crude fiber and total carbohydrate were 8.10, 6.37, 14.03 and 54.54%, respectively.

These results are in agreement with those reported by **Mansour (1991), Al-Jasser and Mustafa (1996), Orthoefer (1996) and Salama *et al.* (1997).**

Also, the chemical analysis of manufactured biscuits (containing 25% rice bran and 10% radicle) under investigation were determined. The obtained data are presented in Table (8).

From these data it could be observed that values of crude protein, total lipids, ash, total carbohydrate and crude fiber

contents were 10.39, 12.64, 2.30, 72.79 and 1.88%, respectively for biscuits manufacturing from rice bran.

However, biscuits supplemented with radicle from barley contained protein content (9.97%) less than biscuits that fortified with rice bran (10.39%).

Also, the crude fiber content was 1.35%, ash amounted to 1.40% and total carbohydrate was 75.67%. These results are related with those reported by **Hudson *et al.* (1992) and Salama *et al.* (1997).**

4.2. Effect of the addition rice bran and radicle flours to wheat flour on rheological properties:

4.2.1. Farinograph properties:

Data in Table (9) and illustrated Fig. (1a, b & c) show the Farinograph parameters of supplemented wheat flour by the addition of 25% rice bran and 10% radicle powder.

The obtained results showed that addition of rice bran flour under the above-mentioned concentration led to increase water absorption which recorded 63.6% compared with wheat flour control, 53.7%. The increasing of water absorption may be due to the strong water-binding capacity of fiber as cited by **Chen *et al.* (1988)**. Also, the arrival time was increased from 0.5 to 6.5 and 1.0 min for wheat flour control, rice bran (25%) and radicle (10%), respectively. On the other hand, dough development time and dough weakening after 20 min were increased for recipe mixtures with rice bran and radicle. While, dough stability increased which recorded 9.0 min for rice bran

and decreased with radicle which amounted to 3.5 min compared with wheat flour as control. From the above-mentioned results it could be concluded that dietary fiber content from different recipe mixtures i.e. rice bran and radicle (34.8 and 43.66%) led to the increment of water absorption, dough development time, dough stability and dough weakening except radicle lower dough stability, these dough characteristics may be attributed to high ability of dietary fiber components to swell and absorp more water and dough become tough. These results are in partial agreement with those reported by **Kennedy *et al.* (1996) and Salama *et al.* (1997)**.

4.2.2. Extensograph properties:

The Extensograph parameters of wheat flour supplemented by rice bran and radicle at concentration of 25% and 10% are presented in Table (10) and Figs (2a, b & c). The data showed that addition of rice bran flour at concentration of 25% to wheat flour (72% ext.) decreased resistance to extension (B.U.), dough extensibility (mm) and dough energy (cm^2) which recorded 380 B.U., 72 mm and 45 cm^2 compared with wheat flour control (595 B.U., 150 mm and 154 cm^2), respectively. While, proportional number of rice bran was increased which amounted 5.3 compared with control (4.0).

The obtained results could be attributed to its low gluten content and characteristics since there are a balance between the extensibility and resistance to extension **(El-Sayed, 1998)**.

On the other hand, the extensograph properties wheat flour (72% ext.) fortified by radicle flour at concentration of 10%

are shown in the Table (10) and illustrated in Fig. (2a, b & c). The achieved results showed that all parameters of extensograph were decreased. These values were 185 B.U., 115 mm, 1.6 and 42 cm^2 with (10%) radicle flour compared with wheat flour control (595 B.U., 150 mm, 4.0 and 154 cm^2) for resistance to extension, dough extensibility, proportional number and dough energy, respectively. These decrease means that the addition of radicle power weakened the dough because of its low content of gluten in the mixtures **(Soliman, 1997)**. Similar observation were obtained by **El-Sayed (1998) and El-Soukkary and El-Sherif (1998a)**.

4.3. Organoleptic evaluation of biscuits supplemented with different levels of rice bran and radicle:

The data in Table (11) presented the mean values of the organoleptic evaluation of biscuits made from wheat flour (72% ext.) supplemented by rice bran and radicle. The results of sensory evaluation showed that biscuits containing different levels of rice bran i.e. 20, 25 and 30% showed no difference in colour, which recorded scores 18.5, 18.8 and 18.6 as compared with score of control (18.3). However, texture, flavour, appearance and taste for other blends had the same scores or higher if compared with control. On the other hand, sensory characteristics of biscuits fortified with different concentration of radicle i.e. 10, 15 and 20% are presented in Table (11). The obtained results showed that the total scores were 87.1, 82.6 and 79.2 at the above-mentioned levels comparing with the total scores of wheat flour as control, 93.9. Gradual reduction was

noticed in all the parameters as the ratio of radicle powder increases. The obtained results may be attributed to these blends need more mixing and fermentation time. These results are in accordance with those obtained by **Soliman (1997), El-Sayed (1998) and El-Shirbeeny *et al.* (2003)**.

4.4. Biological effects of biscuits made of rice bran and radicle on hypercholesterolemic rats:

4.4.1. Effect of experimental diets on body weight gain, food intake and feed efficiency ratio of hypercholesterolemic rats:

Data show the effect on body weight gain, food intake and feed efficiency are presented in Table (12). The obtained results showed that rats fed normal basal diet had the highest mean value of total body weight gain (234.20 g), while rats fed hypercholesterolemic diet had the lowest mean value of total body weight (195.80 g). However, the mean values of total body weight gain were 210.80, 228.40, 206.20 and 203.80 g in rats fed diet biscuits containing rice bran (25%), radicle (10%), rice bran flour (100%) and radicle powder (100%), respectively.

From the above-mentioned results it could be observed that rats fed diets containing biscuits made using 25% rice bran or 10% radicle and rice bran flour or radicle powder had the highest values of body weight gains than that of rats fed hypercholesterolemic diet. But these values had slightly decrement as compared with rats fed basal diet. On the other hand, feed intake in rats fed normal diet which recorded 479.92 g higher than that rats fed hypercholesterolemic diet (348.24 g)

and rats fed biscuits with 25% rice bran (465.18 g) while, food intake in rats fed biscuits with 10% radicle, rice bran 100% flour and radicle powder had the highest values (515.81, 533.25 and 514.12 g), respectively than that rats fed basal diet and hypercholesterolemic diet.

From the above-mentioned results, it could be observed that the addition of the powder of rice bran or barley radicle at different levels improved the body weight gain, food intake and feed efficiency relative to hypercholesterolemic rats. This is may be due to the good nutritional value of rice bran and barley radicle. These results are inagreement with those reported by **El-Soukkary and El-Sherif (1998a) and Kalra and Jood (2000).**

4.4.2. Effect of different experimental diets on organs weight of rats:

The weights of liver, kidneys, heart, spleen and brain expressed as precent of body weight for the different tested diet groups are presented in Table (13). From the obtained results it could be observed that the liver, kidneys, heart and brain of hypercholesterolemic rats had the lowest values than that of rats fed normal diet. While, rats fed biscuits with different levels of rice bran and radicle had similar mean values of liver weight except rats fed biscuits containing 10% radicle if compared to control group. However, the weights of kidneys and brain of rats fed different experimental diets had the lowest mean values than that of rats fed control basal diet. Also, the heart and spleen weights of rats fed hypercholesterolemic diet and different experimental diets had the same mean values with control group.

Similar results were obtained by **Kalra and Jood (2000) and El-Shirbeeny *et al.* (2003)**.

4.4.3. Effect of experimental diets with rice bran and radicle on total cholesterol levels during the experimental period (45 days):

The effect of feeding of rats on the biscuits diets containing fortified with different levels of rice bran and radicle powder on the levels of serum total cholesterol are illustrated in Table (14). The values recorded for serum total cholesterol of rats fed basal, hypercholesterolemic and biscuits containing different levels of rice bran and radicle diets were 121.05, 305.36, 293.00, 274.84, 290.35 and 287.35 mg/100 ml at initial experiment. The levels of total cholesterol of rats fed hypercholesterolemic diet were 301.26, 297.45 and 280.58 mg/100 ml after 15, 30 and 45 days. On the other hand, the total cholesterol contents of rats fed biscuits with (25%) rice bran, 10% radicle, 100% rice bran and 100% radicle after the end of experimental (45 days) amounted to 164.50, 186.11, 148.91 and 133.80 mg/100 ml, respectively when compared with basal diet (125.60 mg/100 ml) and hypercholesterolemic diet (280.58 mg/100 ml). The obtained results are in agreement with those reported by **Kalon and Chow (2000)**.

4.4.4. Effect of different components diets on serum triglycerides, LDL-, HDL-, total cholesterol and risk ratio:

Table (15) shows the effect of biscuits containing different levels of rice bran and radicle on serum triglycerides, total cholesterol, HDL-chloesterol, LDL-cho- and risk ratio of hypercholesterolemic rats after 45 days of experimental period. From the obtained results it could be seen that the rats fed high cholesterol diet had the highest mean values of triglycerides, total cholesterol and LDL-cholesterol (230.80, 280.58 and 193.22 mg/100 ml serum, respectively if compared with rats fed basal diet (120.26, 125.60 and 29.90 mg/100 ml serum, respectively). On the other hand, the mean values of triglycerides were lower (155.45, 161.32, 151.46 and 142.08 mg/100 ml serum) of rats fed biscuits with 25% rice bran, biscuits with 10% radicle, 100% rice bran flour and 100% radicle powder, respectively than that of rats fed hypercholesterolemic diet (230.80 mg/100 ml) but these values were higher than that of rats fed basal diet (120.26 mg/100 ml). However, total cholesterol levels of rats fed biscuits contaning different concentrations of rice bran and radicle had the lowest values as compared with that high cholesterol group.

Risk ratios of hypercholesterolemic rats and rats fed biscuit containing different levels of rice bran and radicle were higher (6.81, 3.20, 3.32, 2.23 and 2.98, respectively) than that of rats fed bsal diet (1.75).

The obtained results are in considered with that of our study were reported by **Peterson (1994), Wilson *et al.* (2002), El-Shirbeeny *et al.* (2003) and Kahlon and Smith (2004).**

4.4.5. Effect of experimental diets on total protein, albumin, globulin, alkaline phosphatase (ALP) and transaminase enzymes of hypercholesterolemic rats:

The mean values of serum total proteins, albumin, globulin, alkaline phosphate (ALP) and aspartate, alanine transaminase (AST and ALT) are presented in Table (16). From the obtained results it could be observed that the mean values of all the above-mentioned parameters had the highest values (7.27, 4.57, 2.70 g/100 ml), 124.78 IU/L, 75.65 and 52.16 U/L) for rats fed hypercholesterolemic diet than that rats fed basal diets (5.99, 3.59, 2.40 g/100 ml, 82.32 IU/L, 54.71 and 24.50 U/L).

On the other hand, rats fed biscuits containing 25% rice bran, 10% radicle or 100% rice bran and 100% radicle had lower values of total protein, albumin and globulin than that of hypercholesterolemic and basal diets. While, rats fed on diets containing biscuits made using the different levels of rice bran and radicle powder had lower values of alkaline phosphate (ALP), AST and ALT enzymes than that of rats fed hypercholesterolemic diet. From the above-mentioned results it could be concluded that the rats fed on biscuits containing rice bran and radicle had improvement in liver functions.

These results are in agreement with those reported by **El-Shirbeeny *et al.* (2003).**

4.4.6. Effect of different experimental diets on Kidneys functions of hypercholesterolemic rats:

Serum urea, uric acid and creatinine are determined as indicators of kidneys functions. Sine the increase in these components means that the kidneys are less active or abnormal case (Table 17). The mean values of urea, uric acid and creatinine were 46.19, 3.51 and 0.86 mg/100 ml for rats fed basal diet, while, the values in hypercholesterolemic rats were 60.08, 5.37 and 1.86 mg/100 ml, respectively. From these results it could seen that kidneys functions are less active in rats fed high cholesterol diet if compared with rats fed basal diet. However, urea contents of rats fed different levels of rice bran and radicle had the same manner mean values when compared with control group. While, uric acid levels were found to be higher than control group and lower than that rats fed high cholesterol diet. In the same line, rats fed diets containing different levels of rice bran and radicle had the lowest levels of creatinine than that of hypercholesterolemic rats. The results are in agreement with that reported by **El-Shirbeeny *et al.* (2003) and Foda (2005).**

4.5. Effect of biscuit supplemented with rice bran and barley radicle diets on biological parameters of diabetic rats:

After consumption of biscuits containing different levels of rice bran and barley radicle of diabetic rats, biological effects at the end of experimental period (5 weeks) were evaluated.

4.5.1. Effect of different experimental diets on body weight gain , food intake and feed efficiency of diabetic rats:

The produced biscuits which was fortified by using rice bran and barley radicle as a by-products were incorporated in a diet for diabetic rats. Table (18) shows body weight gain, food intake, feed efficiency, and feed efficiency ratios of diabetic rats after 5 weeks.

From the obtained results, it could be observed that rats fed basal diet had the highest body weight gain and feed efficiency ratio (F.E.R.), these mean values were 54.60 g and 14.20, respectively. While, rats fed hyperglycemic diet had the very lowest which recorded (-54.20 g) and (-13.8). On the other hand, rats fed biscuits with rice bran (25%) and barley radicle (10%) had improvement of body weight from (-54.20 g) to +7.60 and +10.20 g, respectively. While, the mean values of body weight gain and feed efficiency ratio were (-8.40, -13.40 g) and (-2.4, -4.9 g) for rats fed rice bran and barley radicle 100% without additives, respectively.

From the above results, it could be said that the addition of the rice bran and barley radicle as a by-products at different levels with wheat flour to made biscuits had improved the total body weight and feed efficiency ratios relative to hyperglycemic rats. This is may be due to the good nutritional values of rice bran and barley radicle as a source of soluble dietary fiber **(Kahlon, 2003)**.

Urooj *et al.* (1998) reported that incorporation of barley at suitable levels, it is possible to formulate breads that would cater to the therapeutic needs of various targeted population such

as diabetic and persons suffering from coronary heart diseases. **Bhatty (1992)** found a slight improvement in body weight gain of diabetic rats fed on the barley and their roller flour and bran products.

These results are in agreement with that reported by **Kahlon (2003)**.

4.5.2. Effect of biscuits supplemented using rice bran and barley radicle on organ weights of diabetic rats after 5 weeks:

The weights of liver, kidneys, heart, spleen and brain of diabetic rats fed biscuits supplemented with and without of rice bran and barley radicle are presented in Table (19). From the obtained results, it could observed that the liver, kidneys, heart, spleen and brain weight of basal diet rats had the highest mean values than that of rats fed biscuits made with rice bran, barley radicle and hyperglycemic diet.

These results are in agreement with those reported by **Macrae *et al.* (1994) and Urooj *et al.* (1998)** who found that the addition of barley to the hyperglycemic diet led to a significant increase in liver.

4.5.3. Effect of experimental diets on serum glucose levels of diabetic rats during experimental period:

Table (20) shows the glucose levels of rats fed basal diet, hyperglycemic diet, and biscuits fortified by using rice bran and barley radicle powder replacing with wheat flour. From these

results, the mean values of serum glucose contents were found to be 98.20, 202.32, 206.80, 201.28, 210.48 and 217.56 mg/100 ml at zero time for rats fed basal diet, hyperglycermic diet, biscuit with 25% rice bran, biscuit with 10% radicle, rice bran 100% and radicle 100%, respectively. However, after the first week the levels of glucose was found to be decreased from 206.80 to 191.56 mg/100 ml with rats fed biscuits containing 25% rice bran. At the same line, rats fed rice bran 100% reduced total serum glucose content from 210.48 to 173.86 mg/100 ml. After the end of experimental period (5 weeks), the mean values of serum glucose levels were 95.68, 181.34, 152.68, 152.64, 155.68 and 161.25 mg/100 ml for rats fed basal diet, hyperglycemic diet, biscuit with 25% rice bran, biscuit with 10% barley radicle, rice bran 100% and radicle 100%, respectively. From the above results, it could be observed that the reduction percentage of serum glucose levels about 24.46-26.03% with rats fed all biscuits products when compared with rats fed hyperglycemic diet.

These results are in agreement with these reported by **Urooj *et al.* (1998)** they concluded that the lower post-prandial glucose level as well as the higher satiety produced by barley breads should promote greater consumption of breads rich in soluble fiber by diabetics and other target groups.

4.5.4. Effect of biscuits diets on serum triglycerides, total cholesterol and risk ratio of diabetic rats after 5 weeks:

After 5 weeks of experimental period, serum triglycerides, total cholesterol, HDL-cholesterol, LDL-cholesterol and risk ratio of alloxan-induced diabetic rats were measured and presented in Table (21). From the obtained results, it could be observed that rats fed hyperglycemic diet had the highest values of triglycerides, total cholesterol, LDL-cholesterol and risk ratio. These mean values were 174.20, 208.22, 134.66 mg/100 ml and 5.38, respectively, if compared with rats fed basal diet (119.42, 115.50, 29.25 mg/100 ml and 1.85, respectively).

However, fed rats on diet containing biscuits fortified with 25% rice bran had the lowest mean values of triglycerides, total cholesterol, LDL-cholesterol and risk ratio when compared with that rats fed hyperglycemic diet. On the other hand, these values were found to be 128.64, 130.84, 45.57 mg/100 ml and 2.20 with rats fed rice bran 100% as compared with that rats fed hyperglycemic diet.

However, rats fed diet containing 10% barley radicle had the lowest values (149.46, 166.44, 93.04 mg/100 ml and 3.83) than that of rats fed hyperglycemic diet. From the above-mentioned results, it could be said that biscuits diets containing different levels of rice bran and barley radicle improved the serum triglycerides, total cholesterol, LDL-cholesterol relative to alloxan-induced diabetic rats. The same results with that of our

study were reported by **Bhatty (1992), Hanaa *et al.* (1996) and El-Soukkary and El-Sherif (1998a)**.

4.5.5. Effect of biscuits diets containing rice bran and barley radicle on total protein, albumin, globulin, alkaline phosphatase (ALP) and transaminase enzymes of diabetic rats:

Total protein, albumin, globulin, alkaline phosphatase and aminotransferase enzyme of rats were also assayed. Table (22) shows the levels of these parameters for rats feeding basal diet, hyperglycemic diet and biscuits containing rice bran and barley radicle after 5 weeks. From the above results, total protein, albumin and globulin contents were (6.05, 3.30 and 2.79 g/100 ml) and (7.21, 4.62 and 2.59 g/100 ml) for rats fed basal diet and hyperglycemic diet respectively. Also, in the case of rats fed diets containing rice bran had lower values of these parameters, which recorded 5.90, 3.54 and 2.36 g/100 ml. But rats fed rice bran (100%) and barley radicle (100%) had the same values with that rats fed basal diet. On the other hand, alkaline phosphatase activity was found to be 82.10 and 134.64 IU/L for rats fed basal diet and hyperglycemic diet, respectively. However, these values were 103.33, 96.34, 82.44 and 87.46 IU/L for biscuits with rice bran and barley radicle, rice bran (100%) and barley radicle, respectively. At the same Table also illustrates the activities of aminotransferase enzymes related to liver function (AST and ALT).

Rats fed hyperglycemic diet had a higher value of AST and ALT (60.81 and 36.06 U/L) than that of diabetic rats fed on

basal diet and diet containing biscuits supplemented with rice bran and barley radicle. The values recorded for the above-mentioned diets were (41.33 and 20.05 U/L) for control group and 44.91, 46.39, 45.54 and 47.26 U/L for AST in rats fed biscuit with (25%) rice bran, (10%) barley radicle, rice bran (100%) and radicle powder (100%), respectively.

Similar observation were obtained by **El-Shirbeeny *et al.* (2003)**.

4.5.6. Effect of experimental diets of rice bran and barley radicle on serum urea, uric acid and creatinine contents of diabetic rats:

Total serum urea, uric acid and creatinine as function case of kidneys were evaluated and illustrated in Table (23). Alloxan-induced diabetic rats had the higher values of urea, uric acid and creatinine (65.56, 6.24 and 1.75 mg/100 ml, respectively) than that of rats fed basal diet (46.10, 3.57 and 0.85, mg/100 ml). On the other hand, rats fed diet containing biscuits fortified with rice bran and barley radicle had the lower values of the above parameters than that rats fed hyperglycemic diet. From the obtained results, it could be obsereved that rats fed different diets containing rice bran and radicle at different levels improved the kidneys functions.

These results are in the same with that reported by **El-Shirbeeny *et al.* (2003) and Foda (2005).**