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**RESEARCH ARTICLE**

# The rye bran impact on the serological parameters of the WISTAR rats

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## *Abstract*

This work aims to study the effect of the introduction of rye bran (variety RC9) with 30% in the diet of WISTAR rats on their weight and some serological parameters. Thirty male Wistar rats, weighing on an average of 175 ± 5 g, have been experienced. They received the following experimental diets: a standard diet, a high-calorie diet, and enriched diet with rye bran system.
Measurements conducted on animals show that after a period of 105 days of providing the different diets, the body weight of rats is normal and increases significantly ($p < 0.01$) and only in rats subjected to high-calorie diet.
Glycemia and the levels of total cholesterol, triglyceride and LDL-cholesterol increase mainly with the high-calorie diet and decrease moderately with the standard diets and significantly with the enriched diet with rye bran system to stay in the standards. On the other hand, HDL-cholesterol level is less influenced by the change of regime.
All results are in favor of a beneficial effect of the rye bran fibers on the Wistar rats' metabolic sphere, hence the advantage of incorporating them in the human feed.



## Introduction

Today it is admitted that the food components (energy, protein, minerals, vitamins and micronutrients) play an important role in various aspects of the preventive nutrition (Kouidri and al. 2011).
Indeed, several epidemiological studies have clearly demonstrated that adequate intake of foods containing whole grain cereal has a protective effect against metabolic disorders such as cardiovascular disease, metabolic syndrome, diabetes type 2, and some cancers (Lecerf and Ragot, 2006 Astorg, 2002).
The traditional Mediterranean food has often been associated with a reduced risk of major diseases due to its high dietary fibers. However, this wealth has significantly decreased because of the upheaval of the eating habits by the industrialized countries (Liu, 2003, Liu, 2004).
This study is a continuation of an already published work (Kouidri and al., 2011).
Its objective is to evaluate the consequences of adaptation to a high fiber diet a local neglected cereal for a long time in Algeria, the rye, on the morphological and metabolic dysfunction of the Wistar rats.

## 1. Materials and Methods

**The used vegetable materials**

The local rye bran (variety RC9) was provided by the Technical Institute of large-scale farming of Constantine (ITGC). It was stored in polyethylene airtight bottles (T = 20 ° C and HR = 20-25%).

**Experimental conditions**

Thirty male rats “Wistar race” (*Rattus norvegicus*), weighing 175 ± 5 g, provided by the Pasteur Institute of Algiers, have been studied for a trial period of three months preceded by a period of adaptation of 15 days. The rats were treated in accordance with the advice of the protection and use of laboratory animals (Council of European Communities, 1986). The rearing conditions for all rats are consistent with those followed by Kouidri et al. (2011). During the study, rats were divided into two groups (15 rats in the indicator lot and 15 rats in the experimental lot). The rats received a standard diet (S) in a single morning dose of 15 g / rat during the adaptation period (D0-D15). This diet was maintained throughout the experimental period for the indicator lot (D16-D105). In parallel, the rats of experimental lot received a high-calorie diet (H) for over a month (first experimental period: D16-D45) followed by an enriched diet with rye bran 30% (RB), the formula is presented in Table 1. From D75, three sacrifices were made for each lot with an interval of fifteen days (D75, D90 and D105).

**Weight measurement**

The daily weight of the rats were recorded using the method of Klinger and al. (1996) to study the effect of the RB regime changes of rats’ weight.

**Sacrifices and serological analyzes**

The rats were maintained in drying oven at 37°C for 15 min to allow a peripheral vasodilatation. Then, blood samples were drawn by orbital retro sine (Clive, 2007). Serum samples were collected by low speed centrifugation at 3000 x g at 5°C, for 15 min.

The glycemia was measured according to Tietz (1995), the plasma cholesterol according to the method of Kolodgie and al (2007), the triglycerides plasma according Varela-Lopez and al. (1995), while the HDL-cholesterol fraction was determined according to Gordon and al. (1981).

Furthermore, the concentration of LDL cholesterol was calculated according to the Friedewald and al. formula (1972):

LDL cholesterol = total cholesterol - HDL cholesterol - 1/5 (triglycerides).

**Statistical Analysis**

The data were subjected to statistical analysis using the software “Statistica” Version 6.1 (2004) and the comparisons of the average numbers were performed by the variance analysis (ANOVA).

## 2. Results and Discussion

**Table 1.** Composition of the experimental diets (g/100g of food)

| **Diets’ components** | **Diet types** | | |
|---|---|---|---|
| | **Standard diet** | **High-calorie diet** | **Enriched diet with rye bran** |
| Casein (> 85% protein) | 22.00 | 22.00 | 22.00 |
| DL-methionine | 0.18 | 0.18 | 0.18 |
| Agar-agar | 3.00 | 3.00 | 3.00 |
| Maize starch | 55.82 | 25.82 | 25.82 |
| sucrose | 10.00 | 20.00 | 10.00 |
| Sunflower oil | 5.00 | 5.00 | 5.00 |
| Vitamin complex mineralized | 4.00 | 4.00 | 4.00 |
| Bran | 0.00 | 0.00 | 30.00 |
| saturated lipid | 0.00 | 20.00 | 0.00 |
| Energy value (kJ / g) | 16.95 | 21.14 | 11.93 |

**Weight evolution**

This study sets itself a goal of pursue studies already done by Kouidri and al. (2011) in the same experimental conditions. This yielded a result very close during the adaptation period under regime S, the progressive decrease in body weight is supported by the trend line (Figure 1), and during the first experimental period under regime S and H. this confirms that the change in diet affects the normal development of the body weight over time.

During this period (Figure 2), the body weight of rats receiving the H regime is significantly higher ($p < 0.01$) compared to the rats for which the feed S is distributed; the average weights were respectively 1.4 ± 160.53 g and 166.49 ± 1.3 g for S and H regimes with a difference in weight of 6 g at the end of this period.

The rearing conditions were comparable between the two groups of animals, the weight difference seems related to the nature of the regime ingested, and the H regime is differing from the S regime by an additional concentration of 5 Kcal /g of food. The objective assigned to the H diet, which is causing weight gain.

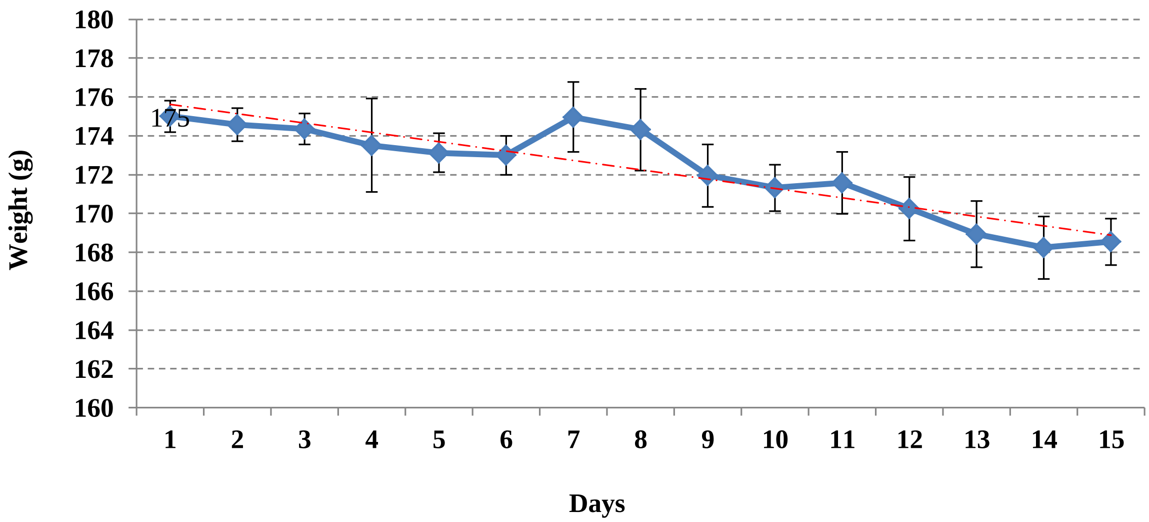


**Figure 1.** Rat weight during the period of adaptation.

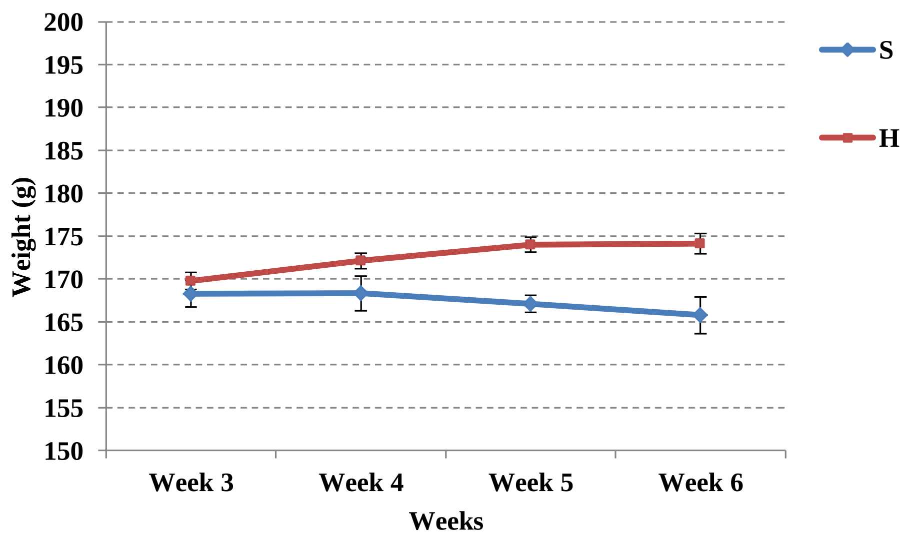


**Figure 2.** Rat weight during the first experimental period (**H**: Hyper caloric diet, S: Standard diet).

During the second experimental period (Figure 3), the animals' body weight continued to receive the standard diet (the S regime ) decreases to stabilize around the 8th week to an average of 1.5 ± 160.38 g calculated over the 7 weeks of rearing (W8 to W14).

The RB regime caused a highly significant reduction (P <0.001) of the rats' body weight from the 7th to the 11th week (Figure 3) to stabilize between the 11th to the 14th week.

This result indicates the significant impact of the consequences of the distribution regime H on the parameters involved in weight gain.

Indeed it took almost 4 weeks RB regime at lower energy content so the animals can gain a comparable weight to those rats fed on the indicating regime (S). The rye bran diet's effect on weight loss is closely linked to the satiating phenomenon induced by the rye fiber.

This result joins the observations of Kouidri and al. (2011) for which a daily diet rich in wheat and barley bran decrease and then stabilize the rats' body weight by a satiating effect.

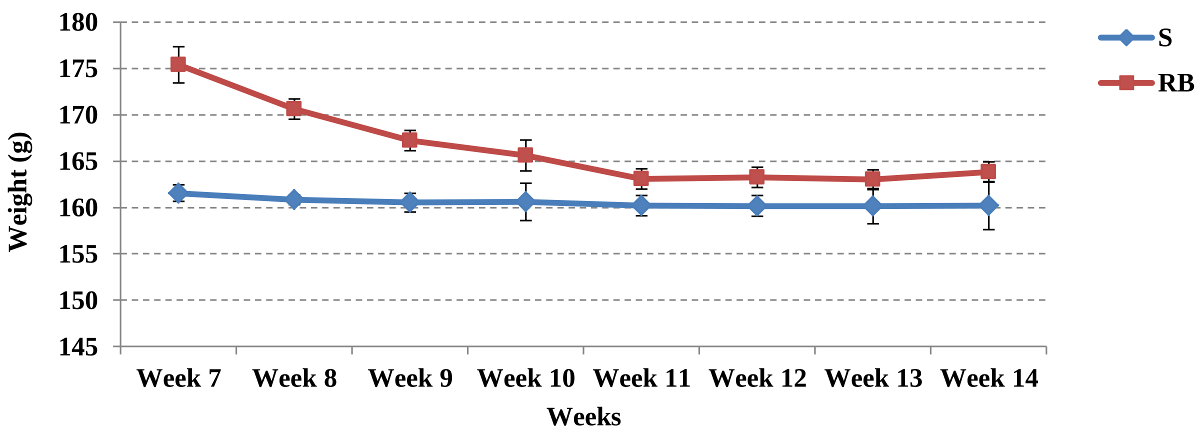


**Figure 3.** Rat weight during the second experimental period (**S**: standard, **RB**: rye bran).

**Evolution of the Serological parameters**

Concerning the adaptation period (D15), of the glycemia analyzes results, triglycerides, total cholesterol, LDL-c and HDL-c made, are in the range of the values reported by Tucker (2003) which considered as standards (Table 2). The glycemia levels, cholesterol, triglycerides, and HDL-c and LDL-c in the indicating lot during the period of adaptation are respectively: 1.16 ± 0.1 g / l, 0.73 ± 0.09 g / l, 0.86 ± 0.04 g / l 0.11 ± 0.01 g / l and 0.44 ± 0.03 g/l. These results reflect the quality of the regime S which allows maintaining the nutritional balance of the rats away from any metabolic disorder.

At the end of the first experimental period (J45), the H diet led to a significant increase (p <0.001) of glycemia, TG, total cholesterol and LDL-c levels. These values remain in standards of Tucker (2003), and they are related to the highest lipid concentration in the diet H compared to the diet S. The impact of the triglyceride in the incidence of the coronary disease has long been the subject of intense debate. Today, hypertriglyceridemia is considered as an independent risk factor of cardiovascular diseases (Hokanson and Austin, 1996). The increase in total cholesterol and LDL-cholesterol is associated with an increasing of the coronary risk (Wanda and al., 2008). The HDL-c concentration in the rats' blood increased with the diet H, without being significant. It is now accepted that HDL-c represents a preventive cardiovascular pathologies risks factor and protective antioxidant (Frost and al., 1999, Jakubowski, 2002, Ford and Liu, 2001).

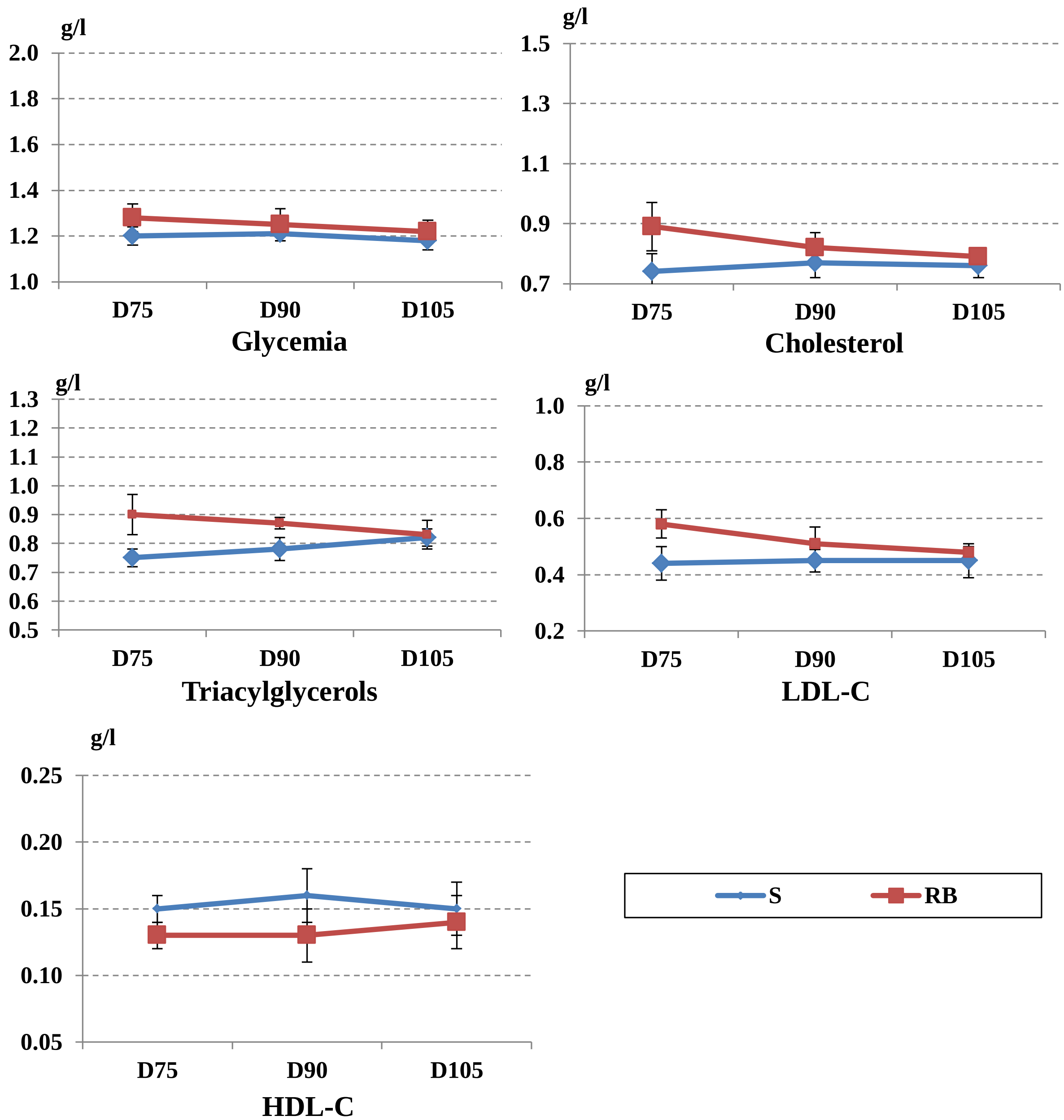


**Figure 4.** Some blood parameters during the second experimental period (**S**: standard, **RB**: rye bran)

During the second experimental period (Figure 4), the diet RB induced a significant decrease ($p < 0.05$) the glycemia, triglycerides, total cholesterol, and LDL-c. All these observed variations (D75 to D105) meet the normal values observed in rats fed on the standard diet (S). The decrease in the glycemia, triglycerides, total cholesterol and LDL-c is related to the reduction of the energy content of the ingested diet where it goes from 21.14 kJ / g (H diet) to 11.93 kJ / g (RB diet) whether a reduction of about 43%.

As opposed to other serological parameters studied, HDL-c experienced a stabilization of its concentration despite the change of diet.

Our results confirm those of Kouidri and al. (2011) which observed that, with Wistar rats, the HDL cholesterol is not changed after 7 weeks of adding the wheat and barley bran to their traditional diet. Furthermore, Lamisse and al. (1987) found the same result after 4 weeks of introduction of wheat bran.

With humans, the low energy value of the regimes enriched with rye cereals has the effect of increasing the level of HDL-c (Leeds, 2002), to facilitate the purification of LDL rich in triglycerides and cholesterol in postprandial phase (Chantre and Lairon, 2002).

The increase in HDL-c, the decrease of the cholesterol and LDL-c levels were observed during a regular consumption of whole grain cereals that promote doubtless protective effect (Liu et al., 1999, Mc Keown et al., 2002).

However, the cereal fibers slow the passage of food and nutrient absorption through the gastrointestinal tract. They can also help to reduce food consumption, since at equal volume; a diet rich in fiber contains less energy than a diet contains a lower value of fiber. (Martin, 2009).

**Table 2.** Summary results of the effects of the incorporation of rye bran on the evolution of serological parameters

| **Periods** | **Diets** | **Days** | **Serological parameters (g/l)** | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Glycemia** | **Triglycerides** | **total Cholesterol** | **HDL – c** | **LDL – c** |
| | | **Standards** | 1.15 – 2.59 | 0.53 – 2.20 | 0.69 – 1.39 | 0.09 – 0.19 | 0.47 – 0.77 |
| **Period of adaptation (D0-D15)** | **Standard (S)** | **D15** | 1.16 ± 0.10 | 0.86 ± 0.04 | 0.73 ± 0.09 | 0.11 ± 0.01 | 0.44 ± 0.03 |
| **The 1st experimental period (D16-D45)** | **Standard (S)** | **D45** | 1.18 ± 0.12 | 0.79 ± 0.04 | 0.72 ± 0.01 | 0.10 ± 0.05 | 0.47 ± 0.02 |
| | **Hypercaloric (H)** | **D45** | 1.30 ± 0.10 | 0.93 ± 0.04 | 0.98 ± 0.08 | 0.13 ± 0.01 | 0.66 ± 0.02 |
| **The 2nd experimental period (D46-D105)** | **Standard (S)** | **D75** | 1.20± 0.04 | 0.75 ± 0.03 | 0.74 ± 0.06 | 0.15 ± 0.01 | 0.44 ± 0.06 |
| | | **D90** | 1.21 ± 0.03 | 0.78 ± 0.04 | 0.77 ± 0.05 | 0.16 ± 0.02 | 0.45 ±0.04 |
| | | **D105** | 1.18 ± 0.04 | 0.82 ± 0.03 | 0.76 ± 0.04 | 0.15 ± 0.02 | 0.45 ± 0.06 |
| | **Rye bran (RB)** | **D75** | 1.28 ± 0.06 | 0.90 ± 0.07 | 0.89± 0.08 | 0.13 ± 0.01 | 0.58 ± 0.05 |
| | | **D90** | 1.25 ± 0.07 | 0.87 ± 0.02 | 0.82 ± 0.05 | 0.13 ± 0.02 | 0.51 ± 0.06 |
| | | **D105** | 1.22 ± 0.05 | 0.83 ± 0.05 | 0.79 ± 0.02 | 0.14 ± 0.02 | 0.48 ± 0.02 |

## 3. Conclusion

In light of the results obtained and in terms of weight, it seems that the presence of rye bran in the RB diet is an important factor to observe a very highly significant decrease in the weight of the rats until stabilization.

Serologically, the results led to note that the contribution of rye in the RB diet caused a very highly significant decrease in the glycemia, TG, cholesterol and LDL-c, to reach the interval normal values of the standard regime (S). The RB diet induced a stabilization of the HDL-c.

Therefore, a diet rich in cereal fiber must be considered a priori desirable, although the mechanisms of the fibers action are not yet all elucidated. Very convincing evidence shows that the fibers have beneficial effects on glucose and lipid metabolism. Therefore it is advisable to increase significantly the proportion of dietary fiber in the usual diet. (Kouidri and al., 2011).

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