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Effect of Wheat and Barley Bran on Weight and Certain Blood Parameters in Wistar Rats

دراسة تأثير نخالة القمح والشعير على وزن وبعض مؤشرات الدم لدى فئران من النوع ويستاير

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Abstract: This study was undertaken to evaluate the effect of food diet supplemented consisting of 30% cereal bran (barley and wheat) on the development of “wistar” rats. Sixty six male “wistar” rats with a mean weight of 173 ± 5g were examined for a period of three months. The experimental diets include a standard diet (S), hyper caloric diet (H), enriched diet with wheat bran (WB) or enriched diet with barley bran (BB). A significant increase ($P<0.05$) in weights was noted especially in rats under hyper caloric diet (H). Glycemia, total cholesterol, triacylglycerols and LDL-C increased in rats under hyper caloric diet and decrease with diets enriched with wheat and barley bran.

Keywords: *Wistar rats,Wheat, barley, bran, weight, glycemia, total cholesterol, triacylglycerols, HDL-C, LDL-C*.

المستخلص: أجريت هده الدراسة لغرض معرفة مدى تأثير إضافة 30 % من نخالة القمح والشعير إلى الوجبة على نمو فئران من النوع ويستاير. وقد وضع تحت التجربة لمدة ثلاثة أشهر ست وستون فأرا ذكرا بمتوسط وزن يساوي 173 ± 5 غ. وقد قدمت لهده الفئران وجبات مختلفة تشمل وجبات مرجعية (S)، وجبات غنية بالطاقة (H)، وجبات أضيف إليها نخالة القمح (WB) ووجبات أضيف إليها نخالة الشعير (BB). وقد لوحظ من خلال النتائج ارتفاع معنوي ($P<0.05$) لوزن الفئران التي تناولت الوجبات الغنية بالطاقة (H). كما ارتفعت نسبة السكر والكولسترول الكلي والجلسريدات الثلاثية والليبوبروتينات ذات الكثافة المنخفضة لدى الفئران التي تناولت الوجبات الغنية بالطاقة بينما انخفضت لدي الفئران التي تناولت الوجبات المضاف إليها نخالة القمح والشعير.

كلمات مدخلية : *فئران ويستاير، قمح، شعير، نخالة، وزن، سكر الدم، كولسترول كلي، جلسريدات ثلاثية، ليبوبروتينات ذات كثافة عالية، ليبوبروتينات ذات كثافة منخفضة.*

INTRODUCTION

It is well known allowed today that foods play important role in various aspects of preventive nutrition. However, nutritional studies were focus mainly on the energy component without sufficiently taking into consideration the quality of the non energetic component of the ration such as "dietary fibers" (Howlett *et al*, 2010).

Dietary fibers were considered for a long time as represented only by vegetable walls (brand), then extended to others component such as gums. Today, dietary fibers are defined as the compounds which can not be digested by human digestive enzymes, i.e. which passes the stomach and the small intestine without being digested (Blackwood *et al*, 2000). On the other hand, a large part of dietary fibers is fermented by colon bacteria, the rest being excreted (Chene, 2003).

The beginning of 20th century, consumed foods contained a sufficient quantity of fibers. Currently, the recommended daily intake of dietary fibers extend from 25 to 40 g/day. It is possible to reach this level with food diets containing many fruits, vegetables and complete cereals (FAO/OMS, 2008). This amount of dietary fibers is necessary to improve intestinal foods transit and reduce cardiovascular diseases and obesity (FAO/OMS, 2007; Adam *et al*. 2003; Slavin, 2003).

Lebars *et al* (2010), specified the effects of dietary fibers and phytosterols on plasmatic LDL-cholesterol, in the dietetic treatment of hypercholesterolemia in childrens. This is why, dietary fibers have considerable health benefits, it helps prevent weight gain and disease, and enhances cardiovascular and gastrointestinal function, and consequently, it becomes important to introduce them in foods (Saura-Calixto, 2011; Anderson *et al*, 2009; Mann & Cumming, 2009). In the study of Ragaee *et al* (2011), whole grains of wheat, rye, barley and oat were used to replace a part of wheat flour in the bread in order to study the effects of dietary fibers on the digestibility of starch *in vitro*. On another side, the work of Lecerf *et al* (2011), reported recently on data relating to the effects of the consuming fiber rich cereals in the breakfast on daily food balance, on the following meals of the day, on body weight, and on certain metabolic parameters.

The object of our study is to evaluate the metabolic effects of incorporating food diet supplemented consisting of 30% cereal bran (barley and wheat) on metabolic and morphological changes in Wistar rats.

Material and Methods

Bran Source

The used bran was obtained from the Technical Institute of Great Cultures of Algiers (ITGC), which include the barley bran (*Hordeum vulgare* L.) Saida variety, and the wheat bran (*Triticum aestivum* L.) Hidhab variety Brans were stored in polyethylene airtight bottles at 20°C and 20 to 25% relative humidity.

Sixty six male ˝wistar˝ rats (*rattus norvegicus*), with a mean weight of 173 ± 5g, provided by the Pasteur Institute of Algiers, were used during the three months of experimental period which was preceded by 15 days adaptation period.

Rats were placed in 22 plastic cages with a steel cover (2 - 4 rats per cage) with dimensions (43x28x18) cm^3. Rats were treated according to the recommendations of the Council of European Communities (Council of European Communities, 1986). Rats were exposed to a daily cycle of twelve hours of light followed by twelve hours of darkness, The temperature was adjusted to 22°C and the average humidity was 55%. The cages were equipped with a renewed sawdust litter each day. Water was provided through libitum.

During the study, rats were distributed between two groups (15 rats for the control group and 51 rats for the experimental group). The two groups of rats received the same standard diet (S) only once in the morning i.e. 15 g/rat for the adaptation period (d0 - d15). This diet was maintained throughout the experimental period for the control group(d16 -d105). In parallel, the rats of the experimental group received a hyper caloric diet (H) for one month (first experimental period: d16 - d45). At the end of this period, three rats were sacrificed in each group (d45). For the second experimental period (d46 - d105), the forty eight rats were divided into four groups receiving four different diet: hyper caloric (H), standard (S), diet enriched with 30 % of wheat bran (WB) and diet enriched with 30 % of barley bran (BB). From d75, three sacrifices were carried out for each group at fifteen days intervals (d75, d90 and d105).

Analyses carried out on these food diets revealed good microbiological and toxicologicalquality according to AFNOR Standards (AFNOR, 1982). The formulas of the diets used during this study and manufactured in the laboratory are presented in table 1. The weight of rats was recorded daily according to the method of Klinger *et al*.(1996) in order to establish growth curve.

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. Glycemia, Triacylglycerols (TG), total cholesterol (TC), HDL- Cholesterol (HDL-C) were determined by enzymatic method (Boehringer Kits, Mannheim, Germany). LDL-Cholesterol (LDL-C) was calculated according to the formula of Friedewald *et al*. (1972): LDL-C = TC – HDL-C – TG/5 (g/l).

Statistical analysis

Data were presented as mean ± standard deviation and were initially analysed by ANOVA. Comparison between two means was performed by Student "T" test and between several means analysis of variance (ANOVA). A probability value of $P<0.05$ was considered significant. All statistical calculations were performed using Statistica version 6.1 software (Statistica Entrprise Wide SPC System "SEWS", Statsoft France, 31 cours des Julliottes F-94700, Maison Alfort- France).

RESULTS AND DISCUSSIONS

During the adaptation period, the weights of rats decrease, but later stabilized at 170.97 ± 4g from the 10th day (d10) (Figure 1). This could be due to the acceptance of the diet.

Table 1. Composition of experimental diets (%).

diet constituents	Types of diets: Standard diet	Hyper caloric diet	Diet with barley bran	Diet with wheat bran
Casein (> 85% Proteins)	22	22	22	22
D-methionine	0.18	0.18	0.18	0.18
Agar-agar	3	3	3	3
Corn starch	55.82	25.82	25.82	25.82
Saccharose	10	20	10	10
Sunflower oil	5	5	5	5
Mineralized vitaminized complex	4	4	4	4
Bran	0	0	30	30
Saturated lipids	0	20	0	0
Metabolisable energy KJ/g	16.95	21.14	11.93	11.93

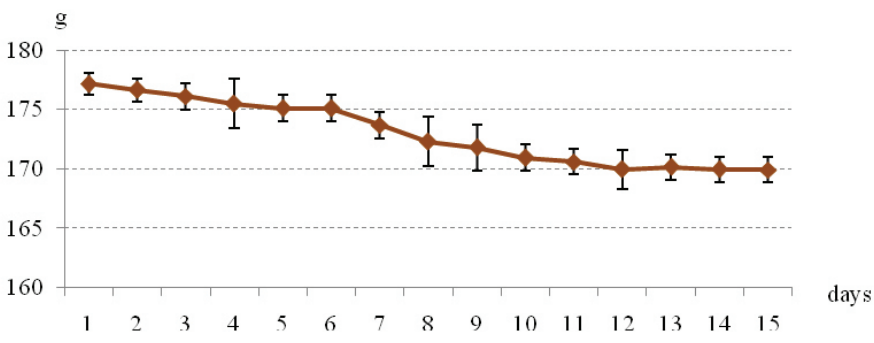

Fig. 1. Rats weights during the period of adaptation.

During the first experimental period, a significant increase (P<0.05) of rats weights was noted in with (H) diet whereas a slight weights loss was recorded with (S) diet (Figure 2). These results are in agreement with the study of Aziz *et al*. (2009) who induced obesity in rats in one of their experiences with a high-fat and -energy diet. In another experience in the same study, these authors demonstrates that high-amylose starch diet led to lower total energy intake, weight gain, fat pad mass, and glycemic response but higher insulin sensitivity index than high-amylopectin starch diet.

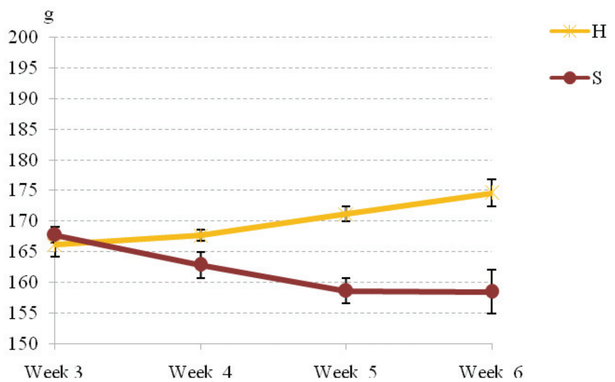

Fig. 2. Rats weights during the first experimental period (H: Hyper caloric diet, S: Standard diet).

The mean rats weights under (S) and (H) diet was at 167.71 ± 3g and 174.31 ± 5g, respectively, with a variation of 6.6 ± 1g at the end of this period. The increased rats weights under (H) diet does not make it possible to draw a hasty conclusion on the influence of the energy contribution on weight gain, because in another study, consumption of carbohydrates solutions enhances energy intake without increasing rat body weight (Ruzzin *et al*, 2005). Body weight seems to be regulated by other mechanisms such us lifestyle, physical activity other than the diet. This test aims to evaluate the response of rats on an overall basis to the increase in the caloric intake under natural rearing conditions.

The continuity of the administration of the (H) diet, during the second experimental period (Figure 3), showed a significant increase record for the first period (p<0.01), but not sufficient enough to cause obesity which is often related to an increase in blood cholesterol and triacylglycerols. This could be due to the composition of the diet (20% of lipids and 45.82% of carbohydrates) (Table 1) and the duration of the treatment (12 weeks). From the twelfth week, rats weight was stabilized at approximately 196 ± 4 g.

The standard (S) diet caused a significant decrease (P< 0.01) in rats weight By week 11, the weight recorded was normal and correspond to (S) diet. In addition, decrease in rats weight was recored for the two diets (BB and WB) but at different levels. The two plots showed parallel tendencies that confirm these results. This decrease is in favour of (BB) diet, and tends to be stabilized from the 10th week. According to several studies, a daily feeding sufficiently rich in fibers have many functions in the diet, one of which may be to promote control of energy intake and reduce the risk of developing obesity This is linked to the unique physico-chemical properties of dietary fibers which aid early signalling of satiation and prolonged or enhanced sensation of satiety. Particularly the ability of some dietary fibers to increase viscosity of intestinal contents offers numerous opportunities to affect appetite regulation (Kristensen & Jensen, 2011; Willis *et al*, 2010; Lyly *et al*, 2010).

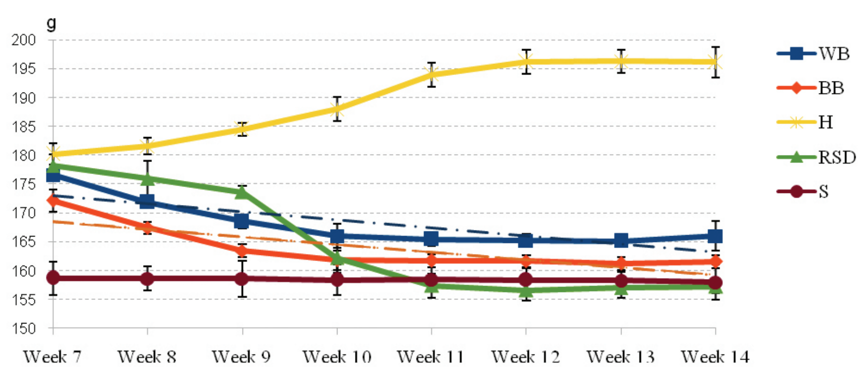

Fig. 3. Rats weights during the second experimental period (H: hyper caloric diet, RSD: return to standard diet, S: standard, WB: wheat bran, BB: barley **bran**).

During the adaptation period (Table 2), some studied parameters like Glycemia, Triacylglycerols, total Cholesterol, HDL-C and LDL-C were in agreement with standards values of Tucker (Tucker, 2003). At the end of the first experimental period (d45), the (H) diet caused a significant increase ($p<0,05$) of glycemia (Figure 4). According to Adam *et al*. (2002), the nature of the introduced carbohydrates has a specific influence on the rise of glycemia after a meal. In the same way, the (H) diet induced a significant increase ($p<0.05$) of total cholesterol concentration. It is known that any modification of energy balance can influence cholesterolemia level. However, diet which is rich in calories and poor in dietary fibers (21,14Kj/g; Table 1) can, according to Afssa (2001), can induce increase of cholesterolemia. This diet also caused a significant increase ($p<0,05$) of TG and LDL-C fraction. Moreover, we note an increase but in significant level of HDL-C which is known for its role in the protection against cardiovascular diseases (Ford *et al*. 2001; Frost *et al*. 1999).

During the second experimental period (Figure 5), the continuity of the (H) diet induced a significant increase ($P<0,05$) in the concentration of certain blood parameters, On the other hand, the addition of bran (WB, BB) caused a significant decrease ($P<0,05$) of glycemia, TG, total cholesterol and of LDL-C, and an increase of HDL-C. According to Kabir *et al*. (2002), Pins *et al*. (2002), the enrichment of diet with cereal fractions of barley always decreases glycemia. Soluble dietary fibers not prevent reduce glucose absorption. These also induce hypocholesterlemia (Caballero *et al*. 2003). Insoluble dietary fibers do not cause hypocholesterolemia (Rieckhoff et al. 1999). However, low energy value of diets enriched with bran cereals increases HDL-C concentration (Leeds, 2002), facilitates purification of LDL rich in triacylglycerols and cholesterol after each meal (Lairon, 2008). The increase of HDL-C, reduction of cholesterolemia and LDL-c concentration were observed during a regular complete cereal consumption which supports, undoubtedly, this protective effect (Liu, 2002; Mc keown *et al*. 2002).

CONCLUSION

In this study, the presence of barley and wheat bran enriched diets is important to reduce glycemia which remains within the normal range. This confirms their effect on carbohydrates metabolism. This study demonstrates also a decrease of total blood cholesterol and LDL-C, accompanied with an increase of HDL-C concentration.

Consequently, a food diet rich in cereal fibers must thus be considered as desirable, even if all mechanisms of action of fibers were not elucidated yet. Very convincing evidence shows that dietary fibers have beneficial effects on carbohydrates and lipids metabolism. It is thus recommended to notably increase the amount of dietary fibers in normal diet. An increased consumption of good quality cereals would permit according to Lioger (2007), to reach the goal of 55 % of carbohydrates energy intake, in particular complex carbohydrates such as starch and fibers, and to improve nutritional profile and to confer benefit health for various foods products (Aymard, 2010). It is also necessary to have an integral vision of cereals in particular rye which is under study.

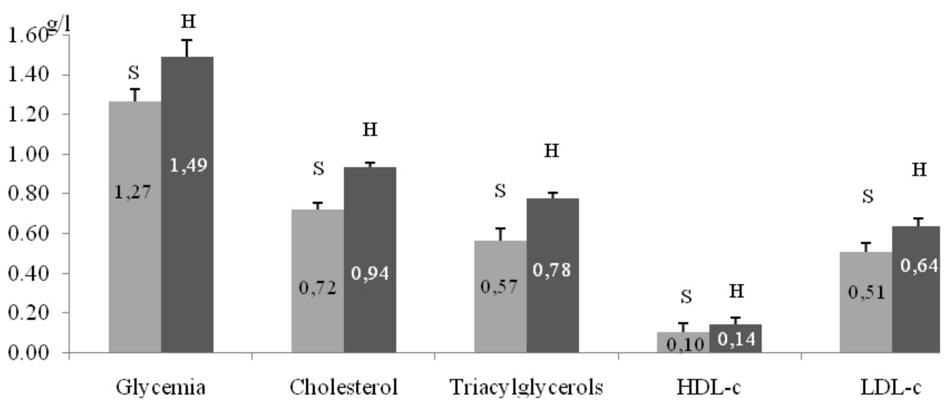

Fig. 4. Some blood parameters after 45 days of experimentation (H: hyper caloric diet, S: standard).

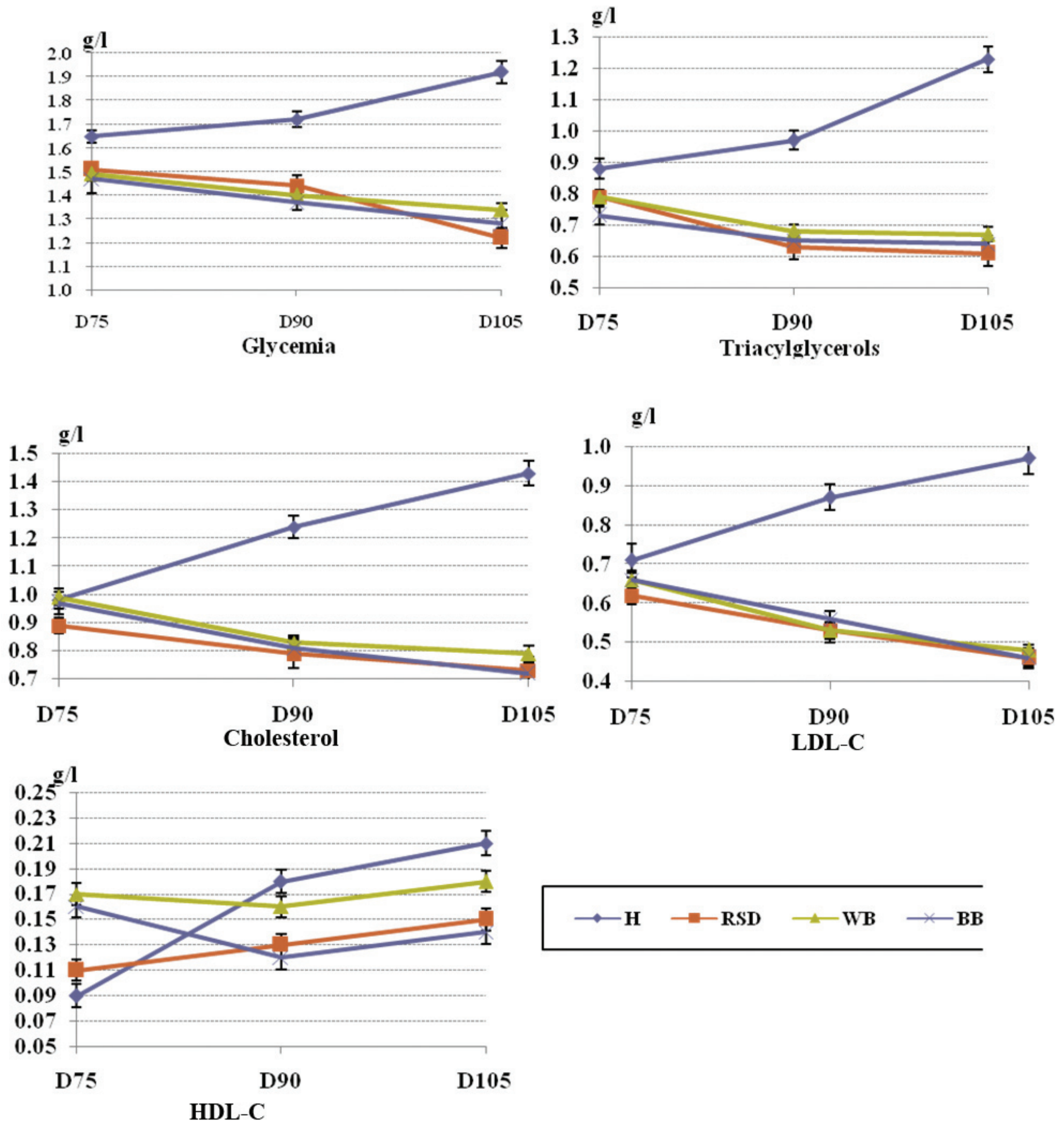

Fig. 5. Some blood parameters during the second experimental period (H: hyper caloric diet, RSD: return to standard diet, S: standard, WB: wheat bran, BB: barley bran)

Table 2. The effect of barley and wheat enriched diets on the evolution of blood parameters.

Periods	Diets	Days	Blood parameters (g/l)				
			Glycemia	**Triacylglycerols**	**Total cholesterol**	**HDL–C**	**LDL–C**
Normal values (Tucker, 2003)			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**	1.19 ± 0.13	0.76 ± 0.03	0.73 ± 0.10	0.18 ± 0.05	0.40 ±0.03
First experimental period (d16-d45)	**Standard (S)**	**d45**	1.27 ± 0.12	0.57 ± 0.05	0.72 ± 0.09	0.10 ± 0.05	0.51 ±0.06
	Hyper caloric (H)	**d45**	1.49 ± 0.15	0.78 ± 0.04	0.94 ± 0.07	0.14 ± 0.01	0.64 ±0.05
Second experimental perio (d46-d105)	**Standard (S)**	**d75**	1.22± 0.05	0.69 ± 0.11	0.84 ± 0.08	0.17 ± 0.07	0.53 ± 0.08
		d90	1.32 ± 0.05	0.82 ± 0.04	0.77 ± 0.03	0.18 ± 0.04	0.43 ±0.05
		d105	1.27 ± 0.04	0.73 ± 0.06	0.80 ± 0.07	0.15 ± 0.05	0.50 ± 0.07
	Hyper caloric (H)	**J75**	1.65 ± 0.06	0.88 ± 0.13	0.98 ± 0.03	0.09 ± 0.01	0.71 ± 0.10
		d90	1.72 ± 0.08	0.97 ± 0.10	1.24 ± 0.11	0.18 ± 0.03	0.87 ±0.07
		d105	1.92 ± 0.06	1.23 ± 0.12	1.43 ± 0.13	0.21 ± 0.04	0.97 ± 0.08
	Return to standard diet (RSD)	**d75**	1.51 ± 0.08	0.79 ± 0.05	0.89 ± 0.05	0.11 ± 0.01	0.62 ± 0.04
		d90	1.44 ± 0.09	0.63 ± 0.06	0.79 ± 0.04	0.13 ± 0.01	0.53 ± 0.05
		d105	1.22 ± 0.06	0.61 ± 0.08	0.73 ± 0.07	0.15 ± 0.03	0.46 ± 0.03
	Wheat bran (WB)	**d75**	1.49 ± 0.03	0.79 ± 0.09	0.99 ± 0.04	0.17 ± 0.02	0.66 ± 0.08
		d90	1.40 ± 0.04	0.68 ± 0.04	0.83 ± 0.06	0.16 ± 0.01	0.53 ± 0.06
		d105	1.34 ± 0.07	0.67 ± 0.10	0.79 ± 0.11	0.18 ± 0.02	0.48 ± 0.11
	Barley bran (BB)	**d75**	1.47 ± 0.08	0.73 ± 0.05	0.97± 0.08	0.16 ± 0.02	0.66 ± 0.07
		d90	1.37 ± 0.05	0.65 ± 0.03	0.81 ± 0.07	0.12 ± 0.01	0.56 ± 0.06
		d105	1.28 ± 0.06	0.64 ± 0.07	0.72 ± 0.12	0.14 ± 0.01	0.46 ± 0.03

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