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# Lipid and glycemic profile of rats fed on diets with banana peel and banana stalk

## Perfil lipídico e glicêmico de ratos submetidos a dietas com fibra da casca e talo de banana

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## Abstract

*Objective*: The aim of this study was to evaluate the effects of dietary intake of fiber present in banana peel and stalk on the blood glucose and lipid profiles of *Wistar* rats. *Methodology:* This research was conducted for 65 days to study the influence of diets containing fiber from banana peel (PGF), banana stalks (SFG) and both types of fiber (PSFG), as compared with the control diet (CG), on the glycemic and lipid profile of 24 male Wistar rats, with a mean initial weight of 54.06 g, distributed equally into four groups. The control group (CG) received the AIN diet plus 1% crystalline cholesterol and 0.1% colic acid and the experimental diets were similar to the control group, except for substitution of the fiber source. *Results:* In the treatment groups (PFG, SFG and PSFG), there was an increase in glycemic, triglyceride and serum total cholesterol and LDL-C levels compared with the control group (CG). The levels of VLDL-C were reduced only in the group containing fibers from the peel. *Conclusions:* Inclusion of dietary fiber from banana peels and stalks, as well as the mixture of both types of fiber, showed effectiveness of use on the lipid profile and the ability to maintain the blood glucose levels of rats fed on diets containing fiber from the peel and the stalk.

**Keywords:** Dietary Fiber. Banana. Glycemia. Rats. Lipids.

## Resumo

*Objetivo:* O estudo teve por objetivo avaliar os efeitos da ingestão de dietas contendo a fibra presente na casca e talo da banana, no perfil glicêmico e lipídico de ratos da linhagem *Wistar. Metodologia:* Estudou-se, durante 65 dias, a influência de dietas contendo fibras provenientes da casca (GFC), talo da banana (GFT) e ambas as fibras (GFCT), em relação à dieta controle (GA), no perfil glicêmico e lipídico de 24 ratos machos da linhagem *Wistar*, com peso médio inicial de 54,06g, distribuídos de forma equitativa em quatro grupos. O grupo controle (GA) recebeu dieta AIN acrescida de 1% de colesterol cristalino e 0,1% de ácido cólico, e as dietas experimentais foram semelhantes ao grupo controle, com substituição da fonte de fibra. *Resultados:* Nos grupos de tratamento (GFC, GFT e GFCT), houve aumento dos níveis glicêmicos, de triglicerídeos e redução do colesterol total e LDL-C séricos, em relação ao grupo controle (GA). Os níveis de VLDL-C mostraram-se reduzidos apenas para o grupo contendo fibras provenientes da casca. *Conclusões:* A inserção de fibra na dieta, proveniente da casca e talo da banana, bem como da mistura de ambos, mostrou efetividade de uso sobre o perfil lipídico e capacidade de manutenção dos níveis de glicemia dos ratos alimentados com dietas contendo fibra oriunda da casca e do talo.

**Palavras-chave:** Fibra Alimentar. Banana. Glicemia. Ratos. Lipídeos.

## Introduction

when people attempt to match their dietary habits to the fast pace of everyday life, they adapt their choices and consumption habits to a new lifestyle. As a consequence, they have been consuming processed foods, which are quick and practical to prepare; however, such foods have low nutritional value and high calorific value, because they contain excess sugar and fat.[1] According to Martins et al.,[2] Brazilians, in little more than twenty years (between 1987 and 2009), increased by more than 10% their intake of ultra-processed foods and by almost 12% their intake of ready meals.

It is known that the consumption of these foods on a large scale leads to a significant increase in the prevalence and incidence of chronic non-communicable diseases (CNCD),[3] e.g. cardiovascular diseases, often caused by dyslipidemias, which cause changes in the levels of circulating lipids,[4] and diabetes, defined by the *Diretrizes da Sociedade Brasileira de Diabetes* (Guidelines of the Brazilian Diabetes Society)[5] as a distinct group of metabolic disorders that have hyperglycemia in common, which results from defects in insulin action, insulin secretion, or both. These pathologies substantially lead to an increase in the number of deaths and in morbidity caused by chronic diseases among adults and the elderly in Brazil.[3]

According to Schmidt et al.,[6] 72% of deaths in Brazil in 2007 were attributed to CNCD, compared with 74% in 2012, according to WHO.[7] Cardiovascular diseases, together with other chronic diseases, including diabetes, accounted for 55.2% of the total number of causes of death in Brazil.[3] Brazilian data for 2011 show that mortality rates for diabetes were 33.7/100 thousand inhabitants, for the general population.[8] They also show that some type of dyslipidemia was found in 59.74% of the population of the municipality of São Paulo in 2008, according to studies conducted by Garcez et al.[9]

Brazil is the subregion (out of eight), according to the division of the Pan American Health Organization (PAHO),[10] with the second highest probability of occurrence of a main chronic disease (such as diabetes, cancer, chronic respiratory disease and cardiovascular disease) in a 30-year-old person.

Some actions should be practiced by individuals who seek prevention and/or treatment of these diseases. One of them is dietary treatment, with nutritionally balanced food, e.g., whole grains, fruits and vegetables. Such food groups are good sources of dietary fiber, which play an important role in the prevention and treatment of chronic diseases, not only of diabetes and dyslipidemias, but also of cardiovascular diseases, cancer, constipation and obesity.[11-13]

Dietary fibers are characterized as a set of substances derived from plants resistant to the action of human digestive enzymes.[14] In the 30th meeting of *Codex Alimentarius*,[15] dietary fiber was defined as the one composed of carbohydrate polymers, with ten or more monomeric units, which have not been hydrolyzed by endogenous enzymes in the small intestine and which may belong to three categories: (I) edible carbohydrate polymers; (ii) carbohydrate polymers obtained from raw material through physical, chemical or enzymatic means; and (iii) synthetic carbohydrate polymers.

As regards total dietary fiber intake for adults, an amount of 25g/day was recommended to women and 30g/day, to men; for patients with diabetes, the recommended daily intake is 14 g of fiber for every 1.000 kcal ingested.[16]

The 5$^{th}$ *Diretriz Brasileira de Dislipidemias e Prevenção da Aterosclerose* (Brazilian Guidelines on Dyslipidemia and Atherosclerosis Prevention) reinforce the magnitude and the evidence that the consumption of soluble fiber is associated with reduction of LDL-C and total cholesterol. Another consideration is that the appropriate intake of this type of fiber is an important factor against the emergence of diabetes, because it can connect with nutrients in the gastrointestinal tract, thus slowing down the absorption of glucose.[17]

The arguments presented above highlight the importance of consumption of high-fiber foods, e.g., by-products such as peels, stalks and leaves. According to David,[18] they represent 30% of the waste of food and vegetables purchased by people, because they lack enough knowledge about the nutritional value of food or about forms of adequate preparation.

As reported by Stork et al.,[19] non-edible parts of foods, for example the stalk, can be used to increase the nutritional value of a meal, because they can be more nutritious than other parts of foods which are considered to be more noble.

In Brazil, in 2013, banana production amounted to seven million tons, hence the country was ranked as the fifth largest world producer of this fruit.[20] It is the fruit of the banana tree *(Musa* sp.), a tropical fruit tree, found throughout the world.[21] In the study by Gondim et al.,[22] it was found that the largest quantities of fibers were found in the peel, when compared with the fresh edible part.

In order to highlight the optimal use of foods and the important role played by dietary fibers in food digestion and prevention of diseases, this study was aimed at evaluating the effects of intake of diets containing fiber from the peel and stalk of bananas on the lipid and blood glucose levels of Wistar rats.

## Methodology

### Characterization of study site and raw material

The biological assay was performed in the *Laboratório de Nutrição Experimental da Faculdade de Nutrição da Universidade Federal de Pelotas* (Experimental Nutrition Laboratory, School of Nutrition, Federal University of Pelotas, UFPel), in Pelotas, RS, southern Brazil. The stalks and peels of banana (cultivar Prata) were supplied by a food store in the city of Pelotas.

### Analytical Methods

To obtain the fiber present in the stalks and peels, the procedures of Beltran[23] were adapted. Stalks and peels of the cultivar Prata were used. The raw material was washed in running water for 15 minutes for dirt removal. After undamaged stalks and peels were selected, they were autoclaved for 30 minutes at a pressure of 1.5 kgf/cm$^2$ at 121°C. The fibers of the autoclaved material were crushed in a household blender and subsequently dried in an oven at 100°C for 24 hours. The resulting material was added to the diet AIN-93G in replacement of fiber in an equivalent quantity among the diets.

At the end of the experimental period, under the supervision of a veterinarian, the rats were anesthetized after 12-hour fast and subsequently beheaded with the use of guillotine for the purpose of blood collection. The whole procedure was performed in accordance with the Resolution of the *Conselho da Faculdade de Medicina Veterinária* (Council of the School of Veterinary Medicine),[24] according to the Ethical Principles in Animal Experimentation adopted by the *Colégio Brasileiro de Experimentação Animal* (Brazilian College for Animal Experimentation) (COBEA)[25] and approved by the *Comissão de Ética em Experimentação Animal* (Animal Testing Ethics Committee) (CEEA)[26], under protocol number 23110.004536/2015-45.

For the assessment of blood glucose level, the collected blood was centrifuged for 3500 rpm at room temperature for ten minutes to obtain blood plasma. For measurement of plasma concentrations, they were dosed and expressed in mG/dL with a Bioclin® colorimetric kit.

For lipid profile analysis, the collected blood was centrifuged for 3500 rpm at room temperature for 10 minutes in order to collect blood serum, which was frozen and stored at -20°C until analysis of lipid fractions.

Serum cholesterol was quantified by an enzyme system (cholesterol esterase, cholesterol oxidase and peroxidase, Labtest Diagnóstica® cholesterol liquiform cat. 76-2/100).

For determination of VLDL, the following formula was used: VLDL triacylglycerol/5 while LDL was determined by the difference of total cholesterol and HDL + (VLDL), as described by Friedwal et al.[27] Triacylglycerols (TGL) were determined by a Labtest Diagnostica® enzyme system (GPO_ANA cat. 59-4/50).

## Biological Methods

The biological assay was conducted with 24 growing male Wistar rats *(Rattus norvegicus)* whose mean weight was 54.06g ± 4.13. They were provided by from the Biotério Central (*Central Vivarium*) at UFPel.

The animals were kept in individual metabolic cages, in a ventilated cabinet, with temperature and relative humidity of respectively 22°C ± 24°C and 65-75%, light/dark cycles of 12 hours and *ad libitum* access to water and feed. The biological assay lasted 65 days; the first five days were meant for adaptation to the diet.

For conduction of the experiment, the recommendations of Reeves et al.[28] were adopted with some modifications. The animals were distributed into randomized blocks and fed four diets which were the experimental treatments in this study. The modified AIN-93G diet was used in the control group (CG), containing 1% cholesterol and 0.1% cholic acid, and the remaining groups received the AING-93 diet, modified for source of fiber: fiber of the banana peel (PFG), fiber of the stalk (SFG) and both types of fiber (PSFG). All diets contained 1% cholesterol and 0.1% cholic acid.

After 59 days (weight maintenance phase), the rats started to be fed on diets formulated according to the AIN-93M diet, while keeping the same percentages indicated above for the fibers, cholesterol and cholic acid.

## Statistical Analysis

The results were expressed as a function of mean and standard deviation, and statistically evaluated. Using analysis of variance (ANOVA), significant differences between means ($p<0.05$) were established by the statistical Tukey's test. For the analyses, the software programs Microsoft Excel 2013 and *Statistica* version 11.0 were used.

# Results

Table 1 shows the mean concentrations of total cholesterol, VLDL-C, LDL-C, triacylglycerols (TGL) and glucose in the serum of rats after 60 days' intake of the experimental diets.

The findings showed a significant reduction ($p<0.05$) of serum cholesterol for animals fed on diets whose source of fiber was the peel - PFG ($140.95 \pm 0.127 mg/dL^{-1}$) and stalk - SFG ($105.37 \pm 0.12 mg/dL^{-1}$). For the latter, there was a reduction by 47.5% of cholesterol levels, when compared with the control diet - CG ($200.95 \pm 0.11 mg/dL^{-1}$).

For LDL-C, there was a significantly representative decrease ($p<0.05$) for the rats fed on the diet whose source of fiber was the stalks - SFG ($28.43 \pm 3.93$ $mg/dL^{-1}$), when compared with the results for the group fed on the control diet - CG ($200.95 \pm 0.11 mg/dL^{-1}$). For VLDL-C and TGL, no statistical differences were found in comparison with the control group.

As regards VLDL-C levels, it should be noted that only in the PFG group the means serum levels were lower than the levels found in the control group (CG). However, there was no statistical difference ($p>0.05$) in serum levels in any of the study groups. A similar result was found when examining the levels of TGL.

Table 1 shows that, for glucose, there was no significant difference ($p>0.05$) in serum levels of rats fed on the PFG and SFG diets, when compared with those who were fed on the CG diet. However, there was a significant increase in glucose levels for the rats fed on the PSFG diet.

**Table 1**. Lipid and blood glucose profile of blood serum (mg/dl) in rats fed on diets containing different sources of fiber (mean ± standard deviation). Pelotas, RS, 2016.

| Group | TC (mg/dL$^{-1}$) | LDL-C (mg/dL$^{-1}$) | VLDL-C (mg/dL$^{-1}$) | TGL (mg/dL$^{-1}$) | Glucose (mg/dL$^{-1}$) |
|---|---|---|---|---|---|
| CG | 200±0.11$^{a}$ | 62±8.74$^{a}$ | 13.56±0.85$^{a}$ | 67.81±0.11$^{a}$ | 100±0.019$^{a}$ |
| PFG | 140.95±0.127$^{bc}$ | 51.73±11.32$^{a}$ | 12.54±2.86$^{a}$ | 62.72±0.13$^{a}$ | 109.97±0.014$^{a}$ |
| SFG | 105.37±0.12$^{c}$ | 28.43±3.93$^{b}$ | 14.40±2.04$^{a}$ | 72.01±0.14$^{a}$ | 121.20±0.04$^{a}$ |
| PSFG | 167.59±0.16$^{ab}$ | 37.27±12.17$^{a}$ | 15.59±3.03$^{a}$ | 76.50±0.20$^{a}$ | 163.69±0.02$^{b}$ |

Means in columns followed by letters differ at a significance level of 5% by Tukey's test. CG: AIN Group (Control); PFG: Peel Group; SFG: Stalk Group; PSFG: Mixed Group; TC: Total cholesterol; VLDL-C: VLDL-cholesterol; LDL-C: LDL-cholesterol; TGL: Triacylglycerols.

For total cholesterol, the results showed that the use of PGF and SFG diets containing soluble fiber (pectin) was statistically effective ($p<0.05$) when compared with the use of the CG diet, which contained insoluble fiber (cellulose). This result is in agreement with the findings of Fietz & Salgado,[29] who found a greater reduction of serum cholesterol levels in Wistar rats fed for 30 days on a diet containing pectin, when compared with those who consumed cellulose.

By contrast, Barroso et al.,[30] in a study with diets containing fibers of the stalk of kale and spinach, both with a predominance of insoluble fiber, found a large reduction in mean serum triacylglycerol. In their study, Sales et al.[31] found that despite the increase, at the end of the experiment, in the levels of LDL-C and TGL in diabetic rats fed on food enriched with oats, flaxseed, sesame and sunflower seeds, such levels were not as high as those of diabetic animals that received the control diet for 50 days.

These results confirm that viscosity is the main property of fiber, and it can reduce the levels of serum cholesterol and serum LDL-C. This occurs as a result of the excretion of bile acids in feces, which ends up causing the conversion of cholesterol from the blood into these acids.[32]

The relationship between the equivalent values of VLDL-C and TGL levels, in the treatment groups, can be explained because these lipoproteins (VLDL) are the main carriers of TGL in plasma.[33]

As regards glucose, type of fiber and physiological action should be taken into consideration. In the byproducts of the banana tree, both in the peel and the stalk, there are soluble and insoluble fibers. A study conducted by Rebello[34] on banana peel identified that the content of insoluble fibers was 83.41% higher than the amount of soluble fibers. This differentiated quality of dietary fibers, from the physiological point of view, leads to a different use of nutrients. In this case, the presence of soluble fibers in the small intestine hampers the action of hydrolytic enzymes, which can prevent the absorption of nutrients, as well as delay digestion.[35] In the case of insoluble fibers, as described by the same authors, there may be reduction in the activity of digestive enzymes, such as lipase and trypsin, chymotrypsin and amylase.

Based on these considerations, it appears that although there was no significant difference for glucose levels of rats fed on diets with peel (PFG) and stalk (SFG) compared with the control diet (CG), there was an increase in this variable for both groups. However, the rats fed on the mixed diet (PSFG) showed a significant increase of blood glucose levels, when compared with the control group (CG). This implies that the physiological effects of the mixture of the two types of fiber have been enhanced, i.e., the action of digestive enzymes was reduced (in this case, amylase), which resulted in a considerable increase of blood glucose levels.

## Conclusions

The intake of dietary fibers from the peel and the stalk of bananas in the diet should be encouraged as part of the adoption of new healthy habits.

In this study, it was concluded that such fibers are able to regulate the lipid profile and to maintain the blood glucose levels of rats, when the fibers of the peel and stalks of bananas are used separately.

## Contributors

Costa TB, Silveira CS, Pereira MC and Helbig E participated in all stages of this research, from the conception of the study until the revision of the final version of the manuscript.

Conflict of Interests: the authors declare no conflict of interest.

## References

1. Louzada MLC, Martins APB, Canella DS, Baraldi LG, Levy RB, Claro RM, et al. Alimentos ultraprocessados e perfil nutricional da dieta no Brasil. Rev Saúde Pública 2015; 49(38):1-11.
2. Martins APB, Levy RB, Claro R M, Moubarac JC, Monteiro CA. Increased contribution of ultra-processed food products in the Brazilian diet (1987-2009). Rev Saúde Pública 2013; 47(4):656-665.
3. Brasil. Ministério da Saúde. Inquérito domiciliar sobre comportamentos de risco e morbidade referida de doenças e agravos não transmissíveis: Brasil, 15 capitais e Distrito Federal, 2002-2003. Rio de Janeiro: INCA; 2004.

4. Hossri CAC, Silva CC. Bioimpedância Elétrica e calorimetria indireta na avaliação nutricional de portadores de Insuficiência Cardíaca. In: Cukier C, Magnoni D, Alvarez T. Nutrição baseada na fisiologia dos órgãos e sistemas. São Paulo: Sarvier; 2005. p. 100-107.

5. Vencio JEPO, organizador. Diretrizes da Sociedade Brasileira de Diabetes (2015-2016). São Paulo: A.C. Farmacêutica; 2016.

6. Schmidt MI, Duncan BB, Silva GA, Menezes AM, Monteiro CA, Barreto SM, et al. Health in 145 Brazil 4. Chronic non-communicable diseases in Brazil: burden and current challenges. The Lancet 2011; 377(9781):1949-1961.

7. Brazil. In: World Health Organization. Mortality and burden of disease. Noncommunicable Diseases (NCD) country profiles, 2014 [Internet]. Acesso em: dez. 2016. Disponível em: http://www.who.int/nmh/countries/bra_en.pdf?ua=1

8. Malta DC, Moura L, Prado RR, Escalante JC, Schmidt MI, Duncan BB. Mortalidade por doenças crônicas não transmissíveis no Brasil e suas regiões, 200 a 2011. Epidemiol Serv Saúde 2014; 23(4):599-608.

9. Garcez MR, Pereira JL, Fontanelli MM, Marchioni DML, Fisberg RM. Prevalência de Dislipidemia segundo estado nutricional em amostra representativa de São Paulo. Arq Bras Cardiol. 2014; 103(6):476-484.

10. Legetic B, Medici A, Hernández-Avila M, Alleyne G, Hennis A, editors. Economic dimensions of non-communicable disease in Latin America and the Caribbean. Disease control priorities. 3. ed. Washington, DC: OPAS; 2016.

11. Bernaud FSR, Rodrigues TC. Fibra alimentar: ingestão adequada e efeitos sobre a saúde do metabolismo. Arq Bras Endocrinol Met. 2013; 57(6):397-405.

12. Aune D, Chan DSM, Lau R, Vieira R, Greenwood DC, Kampman E, et al. Dietary fiber, whole grains, and risk of colorectal cancer: systematic review and dose-response meta-analysis of prospective studies. British Medical Journal 2011; 343:d6617.

13. Anderson JW, Baird P, Davis RH Jr., Ferreri S, Knudtson M, Koraym A, Waters V, Wllims CL. Health benefits of dietary fiber. Nutrition Reviews 2009; 67(4):188-205.

14. Mattos lL, Martins IS. Consumo de fibras alimentares em população adulta. Rev Saúde Pública 2000; 34(1):50-55.

15. World Health Organization. Codex Alimentarius. Report of the 30th Session of the Codex Committee on Nutrition and Foods for Special Dietary Uses; 3-7 Nov. 2008; Cape Town, South Africa.

16. American Diabetes Association. Nutrition recommendations and interventions for diabetes: a position statement of the American Diabetes Association. Diabetes Care 2013; 36(suppl. 1):11-66.

17. Whitney E, Rolfes SR. Nutrição 1: entendendo os nutrientes. São Paulo: Cengage Learning; 2008. 342 p.

18. David DCZP. Comparação da qualidade bioquímica de vegetais, cultivados de modo convencional e não convencional [Tese]. [Botucatu]: Universidade Estadual Paulista, Instituto de Biociência; 2007. 62 f.

19. Stork CR, Nunes GL, Oliveira BB, Basso C. Folhas, talos, cascas e sementes de vegetais: composição nutricional, aproveitamento na alimentação e análise sensorial de preparações. Ciência Rural 2013; 43(3):537-543.

20. Instituto Brasileiro de Geografia e Estatística. Levantamento sistemático da produção agrícola. Pesquisa mensal de previsão e acompanhamento das safras agrícolas no ano civil. Rio de Janeiro: IBGE; 2017. xx,81 p.

21. Figueiredo FP, Mantovani EC, Soares AA, Costa LC, Ramos MM, Oliveira FG. Produtividade e qualidade da Banana prata anã, influenciada por lâminas de água, cultivada no Norte de Minas Gerais. Rev Bras Eng Agríc Ambient. 2006; 10(4):798-803.

22. Gondim JAM, Moura MFV, Dantas AS, Medeiros RLS, Santos KM. Composição centesimal e de minerais em cascas de frutas. Ciênc Tecnol Aliment. 2005; 25(4):825-827.

23. Beltran JER. Uso da polpa da casca da banana prata na formação de placas isolantes. Pelotas [Dissertação]. [Pelotas]: Universidade Federal de Pelotas; 2014.

24. Brasil. Conselho Federal de Medicina Veterinária. Resolução nº 714 de 20 de junho de 2002 [Internet]. acesso em: 30 out. 2015. Disponível em: http://portal.cfmv.gov.br/portal/lei/index/id/327

25. Colégio Brasileiro de Experimentação Animal. Princípios éticos na experimentação animal [Internet]. [acesso em: 21 abr. 2016]. Disponível em: http://www.feis.unesp.br/Home/comissaodeeticaeusoanimal/principios-eticos-na-experimentacao-animal.pdf

26. Universidade Federal de Pelotas. Comissão de Ética em Experimentação Animal. Regimento da comissão de ética em experimentação animal da Universidade Federal de Pelotas [Internet]. Acesso em: 21 abr. 2016. Disponível em: http://wp.ufpel.edu.br/ceea/regimento/

27. Friedwald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low density lipoprotein cholesterol in plasma, without use of preparative ultracentrifuge. Clin Chem. 1972; 18:499-502.

28. Reeves PG, Nielsen FH, Fahey Jr. GC. AIN-93 Purified diets for laboratory rodents: final report of the American Institute of Nutrition Ad Hoc. Writting Committee on the Reformulation of the AIN-76A Rodent Diet. J Nutr. 1993; 123(11):1939-1951.

29. Fietz VR, Salgado JM. Efeito da pectina e da celulose nos níveis séricos de colesterol e triglicerídeos em ratos hiperlipidêmicos. Ciên Tecnol Aliment. 1999; 19(3):318-321.

30. Barroso AKM, Freitas MCJ, Silva VLM. Avaliação das dietas contendo farinhas de talos de vegetais no trato gastrintestinal e parâmetros bioquímicos de ratos. Nutrire: Rev Soc Bras Aliment Nutr. 2009; 34(3):93-107.

31. Sales ALCC, Teixeira JMR, Soares LFM, Damasceno DCF, Almeida IP, Nunes PHM, et al. Dieta enriquecida em fibras e ácidos graxos polinsaturados: efeitos no controle glicêmico e perfil Lipídico de ratos diabéticos. ARS Veterinária 2010; 26(3):138-146.

32. Colli C, Sardinha F, Filisetti TMCC. Alimentos funcionais. In: Cuppari L. Guia de nutrição: nutrição clínica no adulto. São Paulo: Manole; 2005. p. 71-87.

33. Silva MAM, Barcelos MFP, Sousa RV, Lima HM, Falco IR, Lima AL, et al. Efeito das fibras dos farelos de trigo e aveia sobre o perfil lipídico no sangue de ratos (Rattus norvegicus) wistar. Ciênc Agrotec. 2003; 27(6):1321-1329.

34. Rebello LPG. Avaliação de compostos fenólicos, extração e caracterização de pectina em farinha de casca de Banana (Musa AAA) [Tese]. [Viçosa]: Universidade Federal de Viçosa; 2013. 87 f.

35. Flora APL, Dichi I. Aspectos atuais na terapia nutricional da doença inflamatória intestina. Rev Bras Nutr Clin. 2006; 21(2):131-137.

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