Lipid profile of Wistar rats fed normolipid diets with different fatty acid profiles

Perfil lipídico de ratos Wistar submetidos a dietas normolipídicas com diferentes perfis de ácidos graxos

DOI: 10.34117/bjdv7n12-757

Recebimento dos originais: 17/11/2021
Aceitação para publicação: 31/12/2021

Thaís de Souza Oliveira
Master’s degree in Food Science and Technology
Federal Institute of Education, Science and Technology of Mato Grosso (IFMT)
Av. Juliano Costa Marques, s/n, Bela Vista, Cuiabá-MT, Brazil
E-mail: tsonutri@gmail.com

Edgar Willibaldo Allebrandt Neto
Master’s degree in Health Sciences
Federal University of Mato Grosso (UFMT)
Av. Fernando Corrêa da Costa, n° 2367, Boa Esperança, Cuiabá-MT, Brazil
E-mail: edgarwilibaldo@hotmail.com

Wanessa Costa Silva Faria
PhD in Food Science
Federal Institute of Education, Science and Technology of Mato Grosso (IFMT)
Av. Juliano Costa Marques, s/n, Bela Vista, Cuiabá-MT, Brazil
E-mail: wanessacsf@gmail.com

Natalino Francisco da Silva
Master in Integrated Dental Sciences
University of Cuiabá (UNIC)
Rua Profa. Azélia Mamoré de Mello, n° 318, Araés, Cuiabá-MT, Brazil
E-mail: natalino.biologo@hotmail.com

Josete Maria da Silva
PhD student in Animal Bioscience
University of Cuiabá (UNIC)
Rua Vale Verde, n° 415, Centro, Várzea Grande-MT, Brazil
E-mail: silva2010machado@gmail.com

Marcelo Diniz dos Santos
PhD in Zootechny
University of Cuiabá (UNIC)
Rua das Mangabas, n° 1633, Jardim Itália, Cuiabá-MT, Brazil
E-mail: smarcelodiniz@gmail.com
ABSTRACT
The development of cardiovascular diseases is characterized by changes in the blood lipid profile, among other factors, which are closely related to the population's eating habits. Therefore, this study aimed to identify the effects of diets with different lipid sources on the lipid profile of Wistar rats. Forty male and adult rats were used, divided into 5 groups (control - 7% soybean oil, CA - 7% canola oil, CO - 7% coconut oil, SO - 7% sunflower oil and LD - 7% lard) and fed normolipidic diets for 30 days. The variables food consumption, weight gain, weight of organs and adipose tissues, blood glucose, lipid profile and cardiovascular risk indicators in the experimental groups were evaluated in the study. The results showed strong compatibility between the CA and control groups, which did not differ in all variables, however, divergences were identified for the other groups. The LD group consumed 11% more than the control group and together with the CO group, gained the least weight. For the variables weight of organs and adipose tissues, glycemia and cardiovascular risk indicators, no significant differences were observed. Among the lipid profile parameters, the levels of triglycerides, total cholesterol and HDL of animals that consumed sunflower oil and lard were significantly reduced compared to those of animals that consumed soybean oil. For the LDL fraction, all groups were similar to the control group, except for the LD group, which had a 58% lower content. The effects observed in the CO, SO and LD groups seem to result from a deficiency of essential fatty acids, since the respective sources do not meet the requirements of these nutrients.

Keywords: soybean oil, canola oil, coconut oil, sunflower oil, lard.

RESUMO
O desenvolvimento das doenças cardiovasculares é caracterizado, dentre outros fatores, por alterações no perfil lipídico sanguíneo, que estão intimamente relacionadas com os hábitos alimentares da população. Diante disso, este estudo objetivou identificar os efeitos de dietas com diferentes fontes lipídicas sobre o perfil lipídico de ratos Wistar. Foram utilizados 40 ratos machos e adultos, distribuídos em 5 grupos (controle - 7% de
óleo de soja, CA - 7% de óleo de canola, CO - 7% de óleo de coco, SO - 7% de óleo de girassol e LD - 7% de gordura suína) e alimentados com as dietas normolipídicas durante 30 dias. As variáveis consumo alimentar, ganho de peso, peso dos órgãos e tecidos adiposos, glicemia, perfil lipídico e indicadores de risco cardiovascular dos grupos experimentais foram avaliadas no estudo. Os resultados apontaram forte compatibilidade entre CA e o controle, que não diferiram em todas as variáveis, no entanto, divergências foram identificadas para os demais grupos. LD consumiu 11% mais dieta que o controle e, juntamente com CO, foi o grupo que menos ganhou peso. Para as variáveis peso dos órgãos e dos tecidos adiposos, glicemia e indicadores de risco cardiovascular não foram observadas diferenças significativas. Dentre os parâmetros do perfil lipídico, os níveis de triglicerídeos, colesterol total e da fração HDL dos animais que consumiram óleo de girassol e gordura suína reduziram significativamente em comparação aos que consumiram óleo de soja. Já para a fração LDL, todos os grupos se assemelharam ao controle, exceto LD, que apresentou um teor 58% menor. Os efeitos observados nos grupos CO, SO e LD parecem decorrer da deficiência de ácidos graxos essenciais, uma vez que as respectivas fontes não suprem os requerimentos desses nutrientes.

**Palavras-chave:** óleo de soja, óleo de canola, óleo de coco, óleo de girassol, gordura suína.

1 **INTRODUCTION**

Among the several existing lipid sources, some, such as soy oil and lard, are rooted in the dietary habits of the Brazilian population, and others, such as canola, sunflower and coconut oils, have begun to gain popularity at consumers’ tables over the years (BARCELLOS et al., 2011; CATTELAN; DALL’AGNOL, 2018; LIMA; BLOCK, 2019).

This popularity stems from the need to offer foods that present nutritional characteristics meeting the growing demands of an audience seeking healthy eating (CARVALHO; ROCHA, 2011).

This search is linked to concern about the development of diseases with risk factors associated with inadequate eating habits, such as cardiovascular diseases (CVDs) (ASRIH; JORNAYVAZ, 2014; IZAR et al., 2021).

The CVDs are among the diseases killing the most people in the world, and their appearance is closely related to a sedentary lifestyle and obesity, as well as to inadequate eating habits, which include excessive lipid intake (ASRIH; JORNAYVAZ, 2014; IZAR et al., 2021; NEUMANN et al., 2007).

In addition to excessive consumption, entities such as the Brazilian Society of Cardiology warn about the types of lipids and fatty acid (FAs) contents present in the diet (SANTOS et al., 2013). The recommendation is that saturated fatty acids (SFAs) be
ingested in low quantities and that monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) be incorporated into the diet.

This recommendation has been based on the association between the consumption of SFAs and undesirable variations in the lipid profile, such as a decrease in high-density lipoprotein (HDL) and an increase in serum levels of total cholesterol (TC), low-density lipoprotein (LDL) and triglycerides (TGs), which are not observed with the intake of MUFAs and PUFAs (SCHUSTER; OLIVEIRA; BOSCO, 2015; SIRI-TARINO et al., 2010; XAVIER et al., 2013).

These variations also result in changes in cardiovascular risk (CVR) indicators, predictors of the development of CVDs, obtained from TGs/HDL, CT/HDL and LDL/HDL ratios (CASTELLI; ABBOTT; MCNAMARA, 1983; MARTINS et al., 2017).

However, recent studies have provided new perspectives on the subject, raising questions about the effects of SFAs, MUFAs and PUFAs on organisms (KAPPALLY; SHIRWAIKAR; SHIRWAIKAR, 2015; LIMA; BLOCK, 2019; MRÁZOVÁ et al., 2018).

Considering the existence of studies with findings pointing to a different perspective on the types of lipids present in various oils and fats that are part of daily consumption, this work aimed to identify the effects on the lipid profile of Wistar rats fed diets containing different sources of fatty acids through in vivo experimentation.

2 MATERIAL AND METHODS
2.1 EXPERIMENTAL DESIGN

The experimental protocol adopted in this study was approved by the Ethics Committee on the Use of Animals of the University of Cuiabá (CEUA-UNIC) under the number 001/2019.

Forty adult male Wistar rats (approximately 17 weeks) weighing between 240 and 350 g were selected. The animals were made available by the Bioterio of the Veterinary Medicine Faculty of the University of Cuiabá (UNIC) and housed in the experimental room of the graduate school belonging to this educational institution.

After a period of adaptation, the animals were distributed into 5 experimental groups with 8 animals each and kept in individual polypropylene cages with water and ad libitum diet for a period of 30 days.

The experimental groups with their respective lipid sources evaluated were: control - normolipid (7%), soybean oil; CA - normolipid (7%), canola oil; CO -
normolipid (7%), coconut oil; SO - normolipid (7%), sunflower oil and LD - normolipid (7%), lard.

2.2 DEVELOPMENT OF EXPERIMENTAL DIETS

The experimental diets were elaborated with the incorporation of lipid sources in the Laboratory of Biological Food Evaluation of the School of Nutrition of the Federal University of Mato Grosso (FANUT/UFMT) following the nutritional recommendations of the American Institute of Nutrition (AIN) (REEVES; NIELSEN; FAHEY JR., 1993).

Approximately 10 kg of each diet was produced, which was sufficient to provide 40g of diet/animal/day, whose ingredients and lipid content are listed in Table 1.

Table 1. Ingredients and lipid contents of the diets in each experimental group.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Control (g)</th>
<th>CA (g)</th>
<th>CO (g)</th>
<th>SO (g)</th>
<th>LD (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cornstarch</td>
<td>4060</td>
<td>4060</td>
<td>4060</td>
<td>4060</td>
<td>4060</td>
</tr>
<tr>
<td>Dextrinized starch</td>
<td>1355</td>
<td>1355</td>
<td>1355</td>
<td>1355</td>
<td>1355</td>
</tr>
<tr>
<td>Sucrose</td>
<td>1030</td>
<td>1030</td>
<td>1030</td>
<td>1030</td>
<td>1030</td>
</tr>
<tr>
<td>Casein (86% protein)</td>
<td>1850</td>
<td>1850</td>
<td>1850</td>
<td>1850</td>
<td>1850</td>
</tr>
<tr>
<td>Fiber</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Minerals</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>L-Cystine</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Vitamin complex</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Choline bitartrate</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Soybean oil</td>
<td>700</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Canola oil</td>
<td>-</td>
<td>700</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coconut oil</td>
<td>-</td>
<td>-</td>
<td>700</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sunflower oil</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>700</td>
<td>-</td>
</tr>
<tr>
<td>Lard</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>700</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
</tr>
</tbody>
</table>

Control: Soybean oil; CA: Canola oil; CO: Coconut oil; SO: Sunflower oil; LD: lard.

2.3 FOOD CONSUMPTION AND WEIGHT GAIN

Food consumption was calculated by the difference between the quantities offered to the animals and not consumed. Thus, the total consumption per group was estimated by adding up the quantities consumed by each animal and dividing by the number of animals in the group.

The weight gain of the animals was also evaluated by the difference between the weight at the beginning (time 0) and at the end of the experiment (time 30). The total gain per group was calculated by summing the individual earnings and dividing by the number of animals in the group.
2.4 EUTHANASIA

At the end of the experiment, the animals fasted for twelve hours and were then euthanized by decapitation after insensibilization in a carbon dioxide chamber. Blood collection and necropsy were performed to remove organs (heart, liver, lungs, kidneys, spleen and stomach) and adipose tissues (brown, subcutaneous, retroperitoneal and epididymal), which were maintained in 0.9% saline solution.

2.5 WEIGHING OF ORGANS AND FAT TISSUES

Organs and tissues were weighed shortly after necropsy to avoid any interference. The following equation was applied to obtain the relative weights:

Relative weight (%) = (organ or tissue weight/final animal weight) x 100

2.6 BIOCHEMICAL ANALYSIS

Blood was collected in a tube with separator gel and centrifuged at 2500 rpm for 15 minutes to obtain serum, which was then kept under freezing at -40 °C until biochemical analysis was performed, with the exception of glycemia.

The glycemia analysis was performed in duplicate using a commercial Labtest® kit following the manufacturer’s protocol immediately after obtaining the blood and separating the serum to avoid underestimation of the results caused by blood glycolysis.

The lipid profile of the animals (TGs, CT and HDL) were analyzed later by defrosting the samples in duplicate and following the protocols determined in the commercial kits from Gold Analisa®.

The LDL values were obtained from the equation of Friedewald (FRIEDEWALD; LEVY; FREDRICKSON, 1972):

\[ \text{LDL (mg/dL)} = \text{CT - HDL - (TGs ÷ 5)} \]

2.7 CARDIOVASCULAR RISK INDICATORS

Based on the results obtained for lipid profile, cardiovascular risk indicators were calculated for the following parameters: TGs/HDL (MARTINS et al., 2017), CT/HDL and LDL/HDL (CASTELLI; ABBOTT; MCNAMARA, 1983).

2.8 STATISTICAL ANALYSIS

In this study, an Completely Randomized Design (CRD) was applied as the experimental design, including 5 treatments (lipid sources) and 8 repetitions (animals).
The data were analyzed using the software R version 4.1.0 (R CORE TEAM, 2021) with the aid of the packages “nortest” (GROSS; LIGGES, 2015), “agricolae” (MENDIBURU, 2020) and “ExpDes.pt” (FERREIRA; CAVALCANTI; NOGUEIRA, 2018).

The normality of the data was evaluated by the Kolmogorov-Smirnov test. For the parametric data, the CRD (p < 0.05) was applied, and once the existence of a significant difference was verified, the Dunnett test was applied (p < 0.05) to compare the means with the those in the control group. For the nonparametric data, the Kruskal-Wallis (p < 0.05) and Wilcoxon (p < 0.05) tests were applied.

The results obtained are expressed as the mean and standard deviation.

3 RESULTS

From the data of each group obtained from the weight of diets and animals, Table 2 was prepared.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Food consumption (g)</th>
<th>Starting weight (g)</th>
<th>Final weight (g)</th>
<th>Weight gain (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>363.43 ± 26.43a</td>
<td>286.22 ± 44.63</td>
<td>323.02 ± 38.54</td>
<td>36.80 ± 24.57a</td>
</tr>
<tr>
<td>CA</td>
<td>355.59 ± 29.03a</td>
<td>276.32 ± 12.74</td>
<td>319.63 ± 18.58</td>
<td>43.31 ± 22.83a</td>
</tr>
<tr>
<td>CO</td>
<td>347.89 ± 51.87a</td>
<td>298.95 ± 30.53</td>
<td>301.81 ± 45.49</td>
<td>2.86 ± 25.94b</td>
</tr>
<tr>
<td>SO</td>
<td>395.86 ± 44.69a</td>
<td>289.78 ± 29.85</td>
<td>321.83 ± 28.00</td>
<td>32.05 ± 19.03a</td>
</tr>
<tr>
<td>LD</td>
<td>404.89 ± 46.31b</td>
<td>281.19 ± 24.08</td>
<td>289.62 ± 26.16</td>
<td>8.43 ± 8.24b</td>
</tr>
</tbody>
</table>

Control: soybean oil; CA: canola oil; CO: coconut oil; SO: sunflower oil; LD: lard. NS Nonsignificant (p > 0.05). Means with different letters in the columns do differ from the control by Dunnett’s test (p < 0.05).

Lard influenced food consumption, as the LD group consumed the most diet and was the only group that differed statistically from the control group (p < 0.05).

In Table 2, the variables initial weight and final weight did not present significant differences (p > 0.05); however, differences were observed for the weight gain of the animals.

Weight gain was similar among the control, CA and SO groups (p > 0.05), which had the highest means. On the other hand, the CO and LD groups gained 92 and 77% less weight than the control group (p < 0.05), respectively.

Regarding the weights of organs and adipose tissues, the means are arranged in Tables 3 and 4, in this order.
Table 3. The mean relative weight of organs of Wistar rats.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Heart NS</th>
<th>Liver NS</th>
<th>Lungs NS</th>
<th>Kidneys NS</th>
<th>Spleen NS</th>
<th>Stomach NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.38 ± 0.04</td>
<td>2.88 ± 0.30</td>
<td>0.62 ± 0.09</td>
<td>0.80 ± 0.09</td>
<td>0.20 ± 0.02</td>
<td>0.50 ± 0.08</td>
</tr>
<tr>
<td>CA</td>
<td>0.39 ± 0.05</td>
<td>2.95 ± 0.27</td>
<td>0.71 ± 0.13</td>
<td>0.85 ± 0.07</td>
<td>0.23 ± 0.01</td>
<td>0.54 ± 0.12</td>
</tr>
<tr>
<td>CO</td>
<td>0.39 ± 0.06</td>
<td>2.88 ± 0.13</td>
<td>0.72 ± 0.17</td>
<td>0.85 ± 0.13</td>
<td>0.18 ± 0.07</td>
<td>0.56 ± 0.06</td>
</tr>
<tr>
<td>SO</td>
<td>0.38 ± 0.07</td>
<td>2.67 ± 0.45</td>
<td>0.68 ± 0.14</td>
<td>0.80 ± 0.10</td>
<td>0.22 ± 0.03</td>
<td>0.57 ± 0.17</td>
</tr>
<tr>
<td>LD</td>
<td>0.39 ± 0.05</td>
<td>2.73 ± 0.54</td>
<td>0.67 ± 0.07</td>
<td>0.81 ± 0.06</td>
<td>0.20 ± 0.04</td>
<td>0.55 ± 0.06</td>
</tr>
</tbody>
</table>

Control: soybean oil; CA: canola oil; CO: coconut oil; SO: sunflower oil; LD: lard. NS Nonsignificant (p > 0.05).

Table 4. The mean relative weight of adipose tissues of Wistar rats.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Brown NS</th>
<th>Subcutaneous NS</th>
<th>Retroperitoneal NS</th>
<th>Epididymal NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.08 ± 0.05</td>
<td>0.94 ± 0.68</td>
<td>1.66 ± 0.30</td>
<td>1.45 ± 0.64</td>
</tr>
<tr>
<td>CA</td>
<td>0.08 ± 0.03</td>
<td>1.43 ± 0.27</td>
<td>1.61 ± 0.42</td>
<td>2.00 ± 0.30</td>
</tr>
<tr>
<td>CO</td>
<td>0.08 ± 0.05</td>
<td>1.30 ± 0.53</td>
<td>1.44 ± 0.59</td>
<td>2.12 ± 0.44</td>
</tr>
<tr>
<td>SO</td>
<td>0.07 ± 0.03</td>
<td>1.02 ± 0.26</td>
<td>1.41 ± 0.51</td>
<td>1.93 ± 0.58</td>
</tr>
<tr>
<td>LD</td>
<td>0.12 ± 0.07</td>
<td>1.25 ± 0.39</td>
<td>1.35 ± 0.45</td>
<td>2.00 ± 0.66</td>
</tr>
</tbody>
</table>

Control: soybean oil; CA: canola oil; CO: coconut oil; SO: sunflower oil; LD: lard. NS Nonsignificant (p > 0.05).

The control and other experimental groups were statistically similar (p > 0.05) in the evaluation of the relative weight of organs (Table 3) and fat tissues (Table 4).

As shown in Table 5, which provides the biochemical parameters evaluated in this study, glycemia was the only variable that did not influence the diets consumed (p > 0.05).

Table 5. Mean values of the glycemia and lipid profile of Wistar rats.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Glycemia NS</th>
<th>TGs</th>
<th>TC</th>
<th>HDL</th>
<th>LDL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>95.28 ± 2.75</td>
<td>45.43 ± 7.18 (^a)</td>
<td>94.37 ± 15.63 (^a)</td>
<td>27.56 ± 9.70 (^a)</td>
<td>57.72 ± 13.45 (^a)</td>
</tr>
<tr>
<td>CA</td>
<td>91.24 ± 4.68</td>
<td>51.14 ± 11.79 (^a)</td>
<td>107.05 ± 8.52 (^a)</td>
<td>21.41 ± 4.95 (^a)</td>
<td>74.87 ± 18.07 (^a)</td>
</tr>
<tr>
<td>CO</td>
<td>91.50 ± 1.89</td>
<td>36.38 ± 8.91 (^a)</td>
<td>103.99 ± 17.87 (^a)</td>
<td>20.48 ± 14.10 (^a)</td>
<td>76.24 ± 21.50 (^a)</td>
</tr>
<tr>
<td>SO</td>
<td>92.46 ± 4.02</td>
<td>21.41 ± 4.95 (^b)</td>
<td>62.13 ± 19.61 (^b)</td>
<td>15.86 ± 7.53 (^b)</td>
<td>41.99 ± 16.78 (^b)</td>
</tr>
<tr>
<td>LD</td>
<td>90.53 ± 5.32</td>
<td>18.49 ± 6.37 (^b)</td>
<td>36.03 ± 7.73 (^b)</td>
<td>8.07 ± 7.64 (^b)</td>
<td>24.26 ± 11.42 (^b)</td>
</tr>
</tbody>
</table>

Control: soybean oil; CA: canola oil; CO: coconut oil; SO: sunflower oil; LD: lard; TGs: triglycerides; TC: total cholesterol; HDL: high-density lipoprotein; LDL: low-density lipoprotein. NS Nonsignificant (p > 0.05). \(^a\)\(^b\) Means with different lowercase letters in the columns do differ from the control by Dunnett’s test (p < 0.05). \(^A\)^\(^B\) Means with different uppercase letters in the columns do differ from the control by Wilcoxon test (p < 0.05).

Among the lipid profile parameters, TGs, CT and the HDL fraction levels in the CA and CO groups did not differ from those in the control group (p > 0.05).

However, significant differences were observed between the control and the SO and LD groups for these variables (p < 0.05). TGs levels, for example, were reduced by 53% and 59% when the diets consumed contained sunflower oil and lard, respectively.
When analyzing the LDL fraction, which was calculated by the Friedewald equation, only the LD group differed from the control group (p < 0.05), with a 58% lower content.

Table 6 shows the CVR indicators, TGs/HDL, CT/HDL and LDL/HDL.

Table 6. Mean values of the cardiovascular risk indicators of Wistar rats.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Variables</th>
<th>TGs/HDL NS</th>
<th>TC/HDL NS</th>
<th>LDL/HDL NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td>1.79 ± 0.56</td>
<td>3.66 ± 0.99</td>
<td>2.30 ± 0.89</td>
</tr>
<tr>
<td>CA</td>
<td></td>
<td>2.09 ± 0.91</td>
<td>3.86 ± 1.15</td>
<td>2.47 ± 0.99</td>
</tr>
<tr>
<td>CO</td>
<td></td>
<td>1.48 ± 0.51</td>
<td>4.21 ± 0.97</td>
<td>2.91 ± 0.89</td>
</tr>
<tr>
<td>SO</td>
<td></td>
<td>1.63 ± 0.85</td>
<td>3.80 ± 1.24</td>
<td>2.52 ± 1.19</td>
</tr>
<tr>
<td>LD</td>
<td></td>
<td>2.82 ± 1.64</td>
<td>3.73 ± 2.59</td>
<td>2.16 ± 2.06</td>
</tr>
</tbody>
</table>

Control: soybean oil; CA: canola oil; CO: coconut oil; SO: sunflower oil; LD: lard; TGs: triglycerides; TC: total cholesterol; HDL: high-density lipoprotein; LDL: low-density lipoprotein. NS Nonsignificant (p > 0.05).

No significant differences were identified between the control and the other groups (p > 0.05) for any CVR indicator.

4 DISCUSSION

In this study, the evaluation of lipid sources present in the diet of the Brazilian population was performed by simulating the possible effects of consuming these sources on the serum lipid profile and other parameters in Wistar rats.

From the results presented, the CA group was found to be statistically equal to the control group in all variables analyzed. Such similarities have already been identified previously by Antunes et al. (2020) and Ye et al. (2020).

The FAs profiles of soybean and canola oils available in the work of Kim et al. (2020) contain interesting amounts of unsaturated fatty acids, mainly essential ones. In the 1 kg diet of the control group, 38.62 g of linoleic acid (LA) and 4.56 g of \(\alpha\)-linolenic acid (ALA) were included, while the CA diet provided 15.50 and 6.78 g, respectively.

The compatibility between the two oils identified in this study may be related to both meeting the recommendations of essential SFAs for laboratory rats, which recommend 12 g of LA and 2 g of ALA/kg in the diet (REEVES; NIELSEN; FAHEY JR., 1993).

The CO group also did not present a significant difference from the control group for the variables, with the exception of weight gain. In contrast to soy and canola oils, the content of coconut oil offered in the diet is not sufficient to meet the recommended essential fatty acid levels (0.81 g of LA and an undetectable content of ALA/kg in the
diet) (KIM et al., 2020). Thus, the low weight gain in the CO group may be a reflection of the essential fatty acids deficiency (EFAD).

The EFAD promote changes in the structural and biochemical properties of the epidermal barrier, generating water and heat loss through the skin (MELTON et al., 1987). To compensate for thermolysis and maintain homeothermia, resting metabolism is increased, with higher energy consumption and thus a reduction in animal weight (RAFAEL et al. 1988; YAZBECK et al. 1989).

Considering current knowledge about the lipid profile of coconut oil and its effects on the body, which have been addressed in several studies, the expected increases in HDL and LDL (in the form of large, floating and fewer atherogenic particles), as evaluated by the TGs/HDL, TC/HDL and LDL/HDL ratios due to the SFAs content, were not observed in the CO group (KATAN et al., 1994).

The harmful effects on the lipid profile in response to high consumption of lauric acid, one of the main SFAs present in coconut oil, were also not evidenced in the results, possibly due to the period of exposure to the diet. According to Zong et al. (2016), high consumption of some SFAs, such as lauric, myristic, palmitic and stearic acid, presents a positive correlation with an increased risk of coronary heart disease in humans.

For the LD group, which presented the most statistical divergences from the control group, an increase in food consumption was identified, although lard had a considerable content of MUFAs responsible for the prevention of the inflammatory process and hypothalamic resistance to insulin, which reduces food intake (MILANSKI et al., 2009).

Reversal of the effects of MUFAs on food intake control mechanisms may have been caused by hypothalamic resistance to insulin induced by EFAD since, similar to coconut oil, porcine fat alone also does not fulfill essential fatty acid needs (10.40 g LA and 0.47 g ALA/kg diet) (AGRAWAL; GOMEZ-PINILLA, 2012; YE et al., 2019).

The SO group, as well as the LD group, differed from the control group in some variables. However, no changes in food intake and body weights of the animals fed sunflower oil were noted, although this source was deficient in ALA (0.27 g/kg diet) (KIM et al., 2020).

Notably, SO and LD animals had similar lipid profile, but sunflower oil and lard have completely different ω6/ω3 ratios (166:1 and 22:1, respectively) (KIM et al., 2020; YE et al., 2019). Siguel (1996) points out that these high ratios are associated with higher
serum lipid concentrations, however, the two groups had lower TGs, TC and HDL in relation to the others, including the CA group, whose ratio between ω6 and ω3 was 2:1.

Apparently, EFAD may have contributed to the reductions in TGs, TC, HDL and LDL parameters observed previously in studies evaluating the effect of this deficiency on the lipid profile (LÉVY et al., 1989; LYMAN et al., 1966; SANO; PRIVETT, 1980; SINCLAIR; COLLINS, 1968).

Although the decrease in serum lipid levels is theoretically interesting, the development of EFAD promotes inadequate production of pro and anti-inflammatory mediators that may consequently trigger the initiation and progression of the atherosclerotic process (DAS et al., 2007). Therefore, even if the CO, SO and LD groups did not present atherogenic lipid profile, the possibility of these diets inducing atherosclerosis cannot be excluded.

5 CONCLUSION

This study showed the influence of lipid sources on the serum lipid profile and the other variables analyzed and found a strong similarity between the effects resulting from the consumption of soy oils and canola, which were demonstrated to be compatible with the nutritional requirements of the animals.

On the other hand, divergent control behaviors were presented by the groups fed the other sources, especially sunflower oil and lard, whose TGs, TC and HDL levels were relatively lower.

The failure to meet the needs of essential fatty acids during the experiment and the associated consequences were found to be the key points explaining the results found.

Notably, the development of EFAD, although minimally discussed to date, should be considered in the in vivo studies evaluating lipid sources.
REFERÊNCIAS


