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BIOLOGY

Consumo de amêndoa de baru (*Dipteryx alata*) no tratamento de camundongos com obesidade

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ABSTRACT: *The present study evaluated the effects of baru nut consumption on body weight, percent adiposity, amount of adipose tissue and blood levels in obese male Swiss mice. After inducing obesity by providing high-glucose diet (60 days), the mice were divided into 4 groups (7 animals per group) and were fed on a control diet (C), high-glucose diet (HG) or high-glucose diet added with baru (HGBA) or soybean oil (HGSO). Groups fed with diet HGBA had a decrease in the weight gain and glucose and triglyceride levels when compared to diet HG. Aimals fed with HG exhibited a higher proportion of epididymal and retroperitoneal adipose tissue. The inclusion of baru nut in the diet improved the control of weight gain and glucose and triglyceride levels in obese mice.*
Key words: *obesity, functional food, baru nuts.*

Consumption of baru nuts (*Dipteryx alata*) in the treatment of obese mice

RESUMO: *Este estudo analisou os efeitos do consumo de amêndoas de baru no peso corporal, percentagem de adiposidade, quantidade de tecido adiposo e parâmetros sanguíneos em camundongos Swiss machos e obesos. Após indução da obesidade pelo consumo de dieta hiperglicídica (60 dias), os camundongos foram divididos em 4 grupos (7 animais por grupo) e, consumiram dieta controle (C), hipergicídica (HG) ou hiperglicídica com adição de baru (HGBA) ou óleo de soja (HGOS). O grupo que ingeriu HGBA teve redução no ganho de peso e níveis de glicose e triglicérides comparados ao tratamento com dieta HG. Os animais alimentados com HG exibiram uma maior proporção de tecido adiposo epididimal e retroperitoneal. Conclui-se que a inclusão de amêndoa de baru na dieta melhora o controle do ganho de peso e os níveis de glicose e triglicérides em camundongos obesos.*
Palavras-chave: *obesidade, alimento funcional, amêndoas de baru.*

Baru (***Dipteryx alata*** *Vogel*) is a fruit from a native tree in the cerrado region (savanna), Brazil. In addition, the almond portion corresponds to 5% of the fruit, and has a high nutritional value, being rich in lipids, proteins, fibers and minerals, especially calcium (SIQUEIRA et al., 2015). Its almond, pulp, and rind have served as raw material for food industry (NAVES et al., 2010).

Moderate consumption (40-75g per day) of edible seeds, such as baru almonds, improves the serum lipid profile and protects the cardiovascular system (CASAS-AGUSTENCH et al. 2009; NAVES et al., 2010) in individuals with moderate hyperlipidemia (ROS et al., 2004). Consumption of baru almonds also reduces adiposity and improves the lipid profile in women with overweight and obesity (SOUZA, 2014). Therefore, this type of food can be beneficial in the current nutritional and epidemiological transition phase experienced by the Brazilian population, who consume a large amount of saturated fat - and carbohydrate-rich foods (FERNANDES et al., 2015) and have a high obesity prevalence. To further investigate the potential of this food, the present study analyzed the effect of baru almond consumption on the body weight, visceral fat (percent adiposity, amount of adipose tissue) and blood levels (such as triglycerides, total cholesterol, and glucose) in *Swiss* mice with diet-induced obesity.

The obesity was induced in 28 male *Swiss* mice (4-5 weeks old) by ingestion of a high-glucose

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diet for 60 days. After this period the obese mice were divided into 4 groups (7 animals per group) that received (8 weeks; *ad libitum* regimen) control diet (C), high-glucose (HG), high-glucose added with either baru almond (HGBA) or soybean oil (HGSO). The latter group served as a control for addition of lipids to the diet. During the entire experimental period, the animals were kept under the following conditions: 12-h light-dark cycle, temperature: 23 ± 2°C, and water *ad libitum*.

Diet C consisted of a commercial chow for mice (Labina®), containing protein (23.3%), carbohydrates (55.6%), and lipids (2.6%), with a total energy of 4.0kcal g^{-1}. Diet HG consisted of a mixture of hypercaloric food (Labina® chow, 395g; refined sugar, 80g; condensed milk, 395g; and water, 120mL), which was mixed and presented in the form of pellets (protein, 17.5%; carbohydrates, 64.8%; and lipids, 5.0%; and a total energy: 4.4kcal g^{-1}). Diets HGBA and HGSO were also presented as pellets, and were composed of HG diet (1.0kg) added with either ground baru almonds (82g) or soybean oil (36mL), respectively. Both diets presented the same composition: final ethereal extract (46.24%), crude protein (31.75%), fibers (23.58%), moisture (4.09%), and dry (95.91%), mineral (3.93%), and organic (96.07%) materials.

Weights were monitored daily for feed intake and weekly for mice. The weight gain was calculated by the difference between the weights recorded in the current and previous weeks. After the experiment was concluded, animals were decapitated to remove their retroperitoneal (RET), epididymal (EPI), and mesenteric (MES) adipose tissues, which were kept in a freezer (-20°C). The adiposity index was calculated by the sum of the RET, EPI, and MES weights (in grams) divided by the individual weight, and multiplied by 100.

Soon after the animals were killed, blood samples were collected and centrifuged (3000rpm; 4°C; 10min) for serum separation. Serum aliquots were stored frozen (-20°C) in individual vials for subsequent determination of triglycerides, total cholesterol, and glucose using an enzymatic kit (Wiener®, Argentina). Data on the dietary treatments were evaluated using ANOVA, and the statistical differences detected were contrasted using unpaired *t* test. The significance level was established at 5% ($P<0.05$).

The treatment with diet HGBA promoted a lower weight gain (difference ≥2g; 7.65%) in relation to the other treatments. However, food intake was similar among the groups (BA = 4.55g ± 0.64, OS = 4.62g ± 0.84, HC = 5.11g ± 0.65, C = 4.87g ± 0.38), showing that bar nuts did not affect appetite (Figure 1). Mean adiposity was also similar among the groups and under 1.13% (Figure 1). Conversely, different values were reported for fat in specific adipose tissues (Figure 1). Animals fed with HGSO and HG diets showed a greater amount of EPI adipose tissue, and those fedwith HGSO diet exhibited a greater amount of RET adipose tissue as compared to group C. As shown in figure 1, the amount of adipose tissue present in mice fed with HGBA diet was not different from that reported in other animals. In the analysis of blood levels (Figure 1), the values for glucose and triglyceride after the treatment with diets HGBA and C were lower than those obtained after the treatment with diet HG. Regarding the cholesterol levels, differences between groups were not reported.

Our results showed that high-glucose supplementation with baru almond flour had positive effects on mice health, and the group of animals whose diet was supplemented with this ingredient exhibited lower values for body weight gain and blood glucose and triglyceride levels. Control over the weight gain is important to avoid the development of chronic diseases such as diabetes *mellitus*, arterial hypertension, and dyslipidemia. Other studies demonstrated that consumption of edible seeds and true nuts is not associated with weight gain, although these foods contain a high energy value (MARTÍNEZ-GONZÁLEZ & BES-RASTROLLO, 2010). It is likely that baru almond contributes to the weight control by both thermogenic and satiating effects (CASAS-AGUSTENCH et al., 2009) although change in the dietary intake has not been detected in the present study.

Adiposity, which is increased by high-glucose diet intake (FERREIRA et al., 2011), can be controlled by consumption of chestnuts such as nuts, hazelnuts, and sweet almonds (CASAS-AGUSTENCH et al., 2009). In the present study, the proportion of adipose tissue was maintained despite the treatments, probably because the diets tested maintained the same caloric pattern as that of the control diet. However, the diets HG and HGSO increased the amount of fat in some parts of the body (EPI and RET). This result should be considered, as the adipose tissue modulates the lipid and glucose metabolism, and its increase may trigger a dysfunction in these processes, including peripheral insulin resistance (BODEN, 1997).

Diet HG had a negative effect on the blood levels, increasing the glucose and triglyceride levels, which indicated a risk for the development of cardiovascular diseases and diabetes (WOLEVER & MEHLING, 2003). In the group fed with HGBA diet, the negative effect of diet HG was; however, attenuated

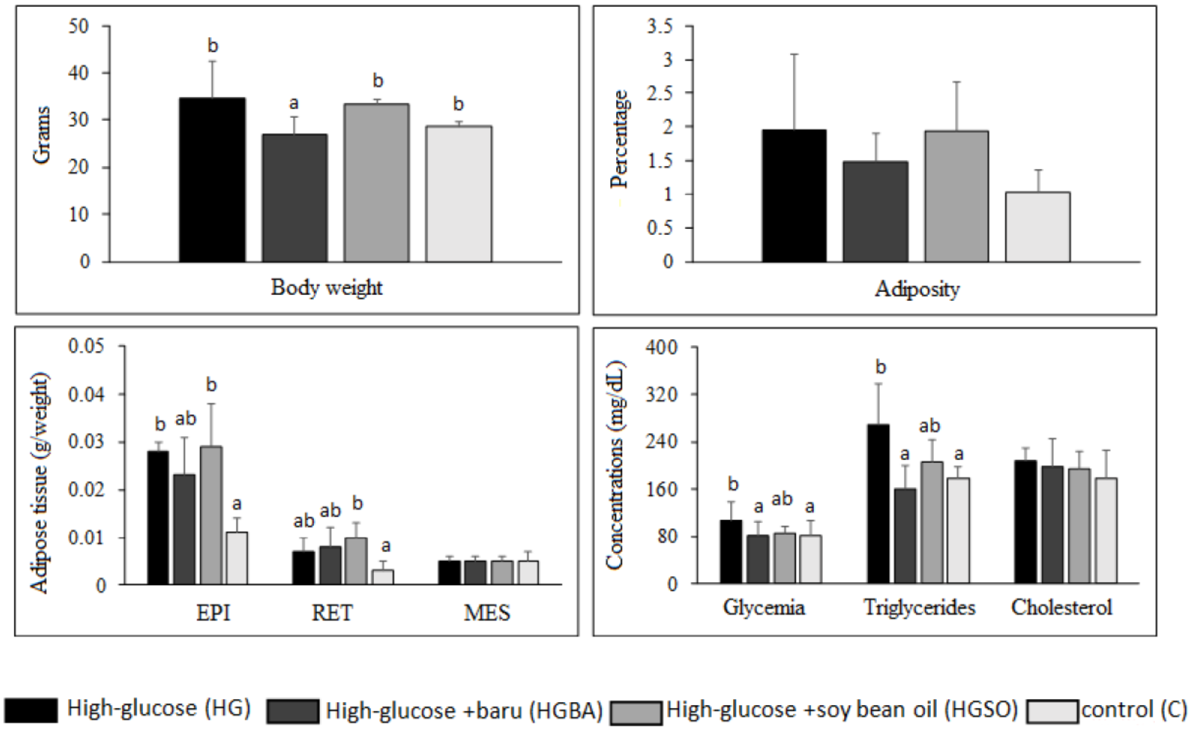

Figure 1 - Body weight, percent adiposity, amount of retroperitoneal (RET), epididymal (EPI), and mesenteric (MES) adipose tissues, and blood levels in obese mice as a function of the diet presented (ANOVA; P<0.05).

by the consumption of baru flour, confirming studies conducted with other almonds (CHOUDHARY et al., 2009). In addition, FERNANDES et al. (2015) showed that the serum levels of total cholesterol and triglycerides in Wistar rats treated with baru almonds are lower than those in animals fed lard. Other studies showed that diet supplementation with baru almonds improved the serum lipid levels in moderately hypercholesterolemic individuals, and recommended this food to prevent cardiovascular diseases (BENTO et al., 2014). However, the cholesterol levels were not different between groups. Further studies with different doses and treatment times should be conducted to examine these differences.

The results indicated that baru flour consumption by obese mice is beneficial, especially because it reduced EPI and RET adipose tissues, which are the main deposits of visceral fat in mice. This food (82g per kg of feed) reduced the weight gain and the glucose and triglyceride levels in mice. Although change in the fat content has not been detected in the tissues, other concentrations and regimens of supplementation with baru flour should be evaluated because the high variance in the data may have masked this effect. The animal model used was suitable for obesity induction, and despite the inherent limitations of extrapolating the effects to other species other studies described the benefits of baru nuts for human health (BENTO, 2014).

Other investigations on baru nuts should be performed to support its use as an alternative source of healthy fats. Their composition is similar to that of true nuts, which are rich of mono - and polyunsaturated fatty acids, in addition to fibers and polyphenols (FREITAS & NAVES, 2010). The studies are especially important for people living in remote Cerrado communities, who have no easy access to other healthy nuts.

REFERENCES

BENTO, A.P. et al. Baru almond improves lipid profile in mildly hypercholesterolemic subjects: a randomized, controlled, crossover study. **Nutrition, metabolism and cardiovascular diseases**, v.24, p.1330-1336, 2014. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25149894>. Accessed: Sept. 17, 2015. doi: 10.1016/j.numecd.2014.07.002.

BODEN, G. Role of fatty acids in the pathogenesis of insulin resistance and NIDDM. **Diabetes**, v.46, p.3-10, 1997. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/8971073>. Accessed: Jan. 06, 2015.

CASAS-AGUSTENCH, P. et al. Effects of one served of mixed on serum lipids, insulin resistance and inflammatory markers in patients with the metabolic syndrome. **Nutrition**, **Metabolism and Cardiovascular Diseases**, v.21, p.126-135, 2009. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/20031380>. Accessed: Jan. 06, 2015. doi: 10.1016/j.numecd.2009.08.005.

CHOUDHARY, P. et al. Almond consumption decreases fasting and past prandial blood glucose level in female type 2 diabetes. **American Journal of Infectious Diseases**, v.5, p.116-118, 2009. Available from: <http://www.researchgate.net/publication/26623445_Almond_Consumption_Decreases_Fasting_and_Post_Prandial_Blood_Glucose_Level_in_Female_Type_2_Diabetes_Subject>. Accessed: Jan. 06, 2015. doi: 10.3844/ajidsp.2009.116.118.

FERNANDES, D.C. et al. Effects of baru almond and Brazil nut against hyperlipidemia and oxidative stress *in vivo*. **Journal of Food Research**, v.4, p. 38-46, 2015. Available from: <http://www.ccsenet.org/journal/index.php/jfr/article/viewFile/46026/26148>. Accessed: Sept. 17, 2015. doi: 10.5539/jfr.v4n4p38.

FERREIRA, A.V.M. et al. High-carbohydrate diet selectively induces tumor necrosis factor-α production in mice liver. **Inflammation**, v.34, p.139-145, 2011. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/20446026>. Accessed: Jan. 06, 2015. doi: 10.1007/s10753-010-9217-0.

FREITAS, J.B.; NAVES, M.M.V. Chemical composition of nuts and edible seeds and their relation to nutrition and health. **Revista de Nutrição**, v.23, n.2, p.269-279, 2010. Available from: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1415-52732010000200010&lng=en&nrm=iso>. ISSN 1415-5273>. Accessed: Jan. 21, 2016. doi: 10.1590/S1415-52732010000200010.

MARTÍNEZ-GONZÁLEZ, M.A.; BES-RASTROLLO, M. Nut consumption, weight gain and obesity: epidemiological evidence. **Nutrition, Metabolism and Cardiovascular Diseases**, v.21 (Suppl.), p.S40-S45, 2010. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21216574>. Accessed: Jan. 06, 2015. doi: 10.1016/j.numecd.2010.11.005.

NAVES, M.M.V. et al. Composição química de nozes e sementes comestíveis e sua relação com a nutrição e saúde. **Revista de Nutrição**, v.23, p.269-279, 2010. Available from: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1415-52732010000200010>. Accessed: Jan. 06, 2015. doi: 10.1590/S1415-52732010000200010.

ROS, E. et al. A walnut diet improves endothelial function in hypercholesterolemic subjects: a randomized crossover trial. **Circulation**, v.109, p.1609-1614, 2004. Available from: <http://circ.ahajournals.org/content/109/13/1609.long>. Accessed: Jan. 06, 2015.

SIQUEIRA, A.P.S. et al. Nutritional quality and bioactive compounds of partially defatted baru almond flour. **Food Science and Technology**, v.35, p.127-132, 2015. Available from: <http://www.scielo.br/pdf/cta/v35n1/0101-2061-cta-35-1-127.pdf>. Accessed: Sept. 17, 2015. doi: 10.1590/1678-457X.6532.

SOUZA, R.G.M. **Efeito do consumo da amêndoa de baru associado à prescrição normocalórica sobre a composição corporal, perfil lipídico e atividade de enzimas antioxidantes em mulheres com excesso de peso**. 2014. 126f. Dissertação (Mestrado em Nutrição e Saúde) – Programa de Pós-graduação em Nutrição e Saúde, Faculdade de Nutrição da Universidade Federal de Goiás, Goiânia, GO.

WOLEVER, T.M.S.; MEHLING, C. Long-term effect of varying the source or amount of dietary carbohydrate on postprandial plasma glucose, insulin, triacylglycerol, and free fatty acid concentration in subjects with impaired glucose tolerance. **American Journal of Clinical Nutrition**, v.77, p.612-621, 2003. Available from: <http://www.ajcn.org/cgi/pmidlookup?view=long&pmid=12600851>. Accessed: Jan. 06, 2015.