



UNIVERSIDADE ESTADUAL DE LONDRINA
CENTRO DE CIÊNCIAS BIOLÓGICAS
COLEGIADO DO CURSO DE CIÊNCIAS BIOLÓGICAS



**Ciências
Biológicas**
UEL

TRABALHO DE CONCLUSÃO DO CURSO DE GRADUAÇÃO EM CIÊNCIAS BIOLÓGICAS

MAYRA DIAS RODRIGUES

PRECONCEPTIONAL TREATMENT WITH AÇAÍ JUÇARA (*Euterpe edulis* Martius) IN ADVANCE-AGED RATS: EVALUATION OF METABOLIC, OXIDATIVE AND LITTER PARAMETERS IN PREGNANCY

Londrina – Paraná
2024

**TRABALHO DE CONCLUSÃO DO CURSO DE GRADUAÇÃO
EM CIÊNCIAS BIOLÓGICAS**

MAYRA DIAS RODRIGUES

**PRECONCEPTIONAL TREATMENT WITH AÇAÍ
JUÇARA (*Euterpe edulis* Martius) IN
ADVANCE-AGED RATS: EVALUATION OF
METABOLIC, OXIDATIVE AND LITTER PARAMETERS
IN PREGNANCY**

Monografia apresentada ao Curso de Graduação em Ciências Biológicas da Universidade Estadual de Londrina como um dos requisitos à obtenção do título de Bacharel em Ciências Biológicas.

Orientador: Graziela Sciantti Ceravolo

Londrina – Paraná
2024

Ficha de identificação da obra elaborada pelo autor, através do Programa de Geração Automática do Sistema de Bibliotecas da UEL

M474p Rodrigues, Mayra Dias.
Preconceptional treatment with açai juçara (*Euterpe edulis Martius*) in advance-aged rats : evaluation of metabolic, oxidative and litter parameters in pregnancy / Mayra Dias Rodrigues. - Londrina, 2024.
37 f.

Orientador: Graziela Scialanti Ceravolo.
Trabalho de Conclusão de Curso (Graduação em Ciências Biológicas) - Universidade Estadual de Londrina, Centro de Ciências Biológicas, Graduação em Ciências Biológicas, 2024.
Inclui bibliografia.

1. Gravidez - TCC. 2. Idade materna avançada - TCC. 3. Juçara - TCC. I. Ceravolo, Graziela Scialanti. II. Universidade Estadual de Londrina. Centro de Ciências Biológicas. Graduação em Ciências Biológicas. III. Título.

CDU 612

BANCA EXAMINADORA

Profa. Dra. Graziela Scaliante Ceravolo

Profa. Me. Karina Nicole Sobota

Profa. Dra. Kawane Fabrício Moura

Profa. Dra. Glaura Scantamburlo Alves Fernandes (suplente)

Londrina, 19 de abril de 2024

AGRADECIMENTOS

Agradeço primeiramente a Deus, por me dar forças e condições para que eu conseguisse desenvolver este trabalho e completar esses 5 anos de graduação. Agradeço por ter me abençoado desde o momento do meu ingresso no curso até o momento da apresentação deste trabalho.

Eu sou extremamente grata aos meus pais, por sempre me apoiarem nas minhas decisões e por todo o suporte durante todos esses anos. É claro que sempre cuidaram de mim, mas dedico aqui meu agradecimento referente aos anos da graduação. Sem eles, o desenvolvimento deste trabalho não seria possível. Eu agradeço por me deixarem e incentivarem morar em outro estado para ingressar na universidade, eu agradeço por me trazerem até aqui, eu agradeço por me sustentarem durante todo o período da graduação, eu agradeço por terem assistido à minha formatura, eu agradeço por estarem comigo em momentos difíceis, e eu agradeço por estarem presentes no dia da apresentação deste trabalho.

Eu gostaria de agradecer à Universidade Estadual de Londrina por fornecer um curso de muita qualidade e eu agradeço ao curso de Ciências Biológicas, ao colegiado, a todos professores e aos meus colegas de turma por isso e pela oportunidade de conhecer vários lugares e ter me ajudado a descobrir a minha vocação.

Não posso deixar de agradecer a todos que fizeram parte da minha trajetória da graduação, principalmente durante a pandemia, as pessoas que me ajudaram a me fortalecer e a manter minha saúde mental, sem nem ter conhecimento disso. Além dos meus pais, agradeço aos meus colegas de trabalho, aos meus tios e tias, tio Zé, tio Julio, tia Doquinha e tia Sônia, as minhas primas

Heloísa, Maria Julia e Laura e às minhas amigas Ana Clara e Beatriz. Também sou grata a todos os meus parentes pela torcida e orgulho.

Sou grata aos amigos que fiz no curso de Ciências Biológicas, Karen, Fabiane, Maria, Rafaela, Rebecca, Vitória e Emiliano, por me apoiarem e por todos os momentos da graduação, passei muitos momentos felizes ao lado de cada um. Também agradeço ao Joey pelas palavras de motivação, pelas comemorações, por estar ao meu lado e por me ouvir todas as vezes que contava e explicava sobre este trabalho.

Agradeço à minha amiga Carol, pela nossa amizade durar tantos anos e, mesmo estando longe, ainda nos incluímos em momentos importantes das nossas vidas.

Gostaria de agradecer a professora Karla e a mestre Brenda pela colaboração em todas as etapas deste trabalho, sem elas a realização desse estudo não seria possível.

Eu agradeço a professora Graziela por me deixar fazer parte do laboratório de Farmacologia Vascular, por confiar em mim para realização de todas as partes deste trabalho, pelas orientações e por me ajudar a conhecer mais a área de pesquisa e evoluir como pesquisadora. Também agradeço aos meus colegas de laboratório e a doutora Kawane por toda ajuda, e por todos os ensinamentos e conhecimento que obtive nesses anos na pesquisa.

RODRIGUES, Mayra Dias. **Preconceptional treatment with açai juçara (*Euterpe edulis* Martius) in advance-aged rats: evaluation of metabolic, oxidative and litter parameters in pregnancy.** 2024. 37 fls. Trabalho de Conclusão de Curso (Graduação em Ciências Biológicas) – Universidade Estadual de Londrina, Londrina. 2024.

RESUMO

Cuidados pré-concepcionais incluem mudanças comportamentais como uma boa alimentação e podem significar um preparo para as mulheres que optaram por adiar a gravidez. O consumo do açai juçara (*Euterpe edulis* Martius) pode ser benéfico à saúde. Estudos descreveram que o tratamento com açai ou seus compostos melhora as condições de indivíduos não saudáveis, além de apresentar possível efeito protetor. Entretanto, não se sabe se o tratamento pré-concepcional com açai juçara afetaria os parâmetros em mulheres saudáveis em idade materna avançada. Assim, este estudo teve como objetivo avaliar os efeitos do tratamento da polpa de juçara, antes do período gestacional, sobre os parâmetros biométricos, metabólicos, oxidativos e de ninhada de ratas prenhes em idade avançada. Ratas Wistar fêmeas saudáveis foram tratadas com polpa de juçara durante seis semanas e depois colocadas para acasalar com machos. Quando grávidas, foram medidos a tolerância materna à glicose, o peso corporal e dos tecidos, colesterol total, HDL (high-density lipoprotein), triglicerídeos e biomarcadores de estresse oxidativo, e seus filhotes foram pesados e contados. Os resultados deste estudo mostram que o tratamento com polpa de juçara, antes da gravidez, reduziu os níveis de glicose basal, mas não interferiu nos demais parâmetros avaliados, sugerindo que a intervenção nutricional com juçara pode ser segura para mulheres em preparação para a gravidez em idade avançada.

Palavras-chave: Gravidez. Idade materna avançada. Juçara.

RODRIGUES, Mayra Dias. **Preconceptional treatment with açai juçara (*Euterpe edulis Martius*) in advance-aged rats: evaluation of metabolic, oxidative and litter parameters in pregnancy.** 2024. 37 pgs. Final Dissertation (Biological Sciences Undergraduation) – Universidade Estadual de Londrina, Londrina. 2024.

ABSTRACT

The preconceptional care includes behavioral changes such as good nutrition and can mean a preparation for women who chose to postpone pregnancy. The consumption of açai juçara (*Euterpe edulis Martius*) can be beneficial to health. Studies described that treatment with açai or its compounds improves conditions for unhealthy individuals, in addition to showing a possible protective effect. However, it is not known if the preconceptional treatment with açai juçara would affect parameters in health-aged females. So this study aimed to evaluate the effects of the juçara pulp treatment, before the gestational period, on the biometric, metabolic, oxidative and litter parameters of pregnant rats at an advanced maternal age. Healthy female Wistar rats were treated with juçara pulp for six weeks and then put for breeding with males. When pregnant, maternal glucose tolerance, body and tissue weights, total cholesterol, high-density lipoprotein, triglycerides, and biomarkers of oxidative stress were measured, and their offspring were weighed and counted. The results of this study show that the juçara pulp treatment, before pregnancy, reduced basal glucose levels, but didn't interfere in the other parameters evaluated, which suggests that the nutritional intervention with juçara can be secure for women in preparation for pregnancy at an advanced age.

Keywords: Advanced maternal age. Juçara. Pregnancy.

LISTA DE FIGURAS

Figura 1 – Experimental design	19
Figura 2 – Basal glycemia (mg/dL) of the different experimental groups.....	24
Figura 3 – Oral glucose tolerance test (OGTT) of the different experimental groups	24
Figura 4 – Maternal lipid profile of the different experimental groups	25
Figura 5 – Maternal biomarkers of oxidative stress in the liver	26

LISTA DE TABELAS

Tabela 1 – Maternal weight tracking (g) after the treatment period	23
Tabela 2 – Maternal biometric parameters of the different experimental groups.	25
Tabela 3 – Litter size and weight of the different experimental groups	27

SUMÁRIO

	Pág.
1. INTRODUÇÃO.....	11
2. REVISÃO BIBLIOGRÁFICA	12
2.1 Juçara (<i>Euterpe edulis</i> Martius)	12
2.2 Reprodução em idade avançada	13
2.3 Nutrição materna no período pré-concepcional.....	14
3. ARTIGO CIENTÍFICO	16
4. CONCLUSÕES	34
REFERÊNCIAS	34

1. INTRODUÇÃO

A palmeira juçara (*Euterpe edulis* Martius) é uma árvore nativa da Mata Atlântica e o seu fruto, o açaí juçara, de coloração quase preta, possui importante papel ecológico (Godoy, 2022) e possível papel econômico pelas suas propriedades nutricionais. As aplicações da polpa do açaí juçara vem sendo estudadas por ser um produto natural com compostos benéficos a saúde como vitaminas, fibras alimentares, e, seu principal pigmento, a antocianina, além de outros compostos fenólicos presentes no fruto, contém propriedades antioxidantes (Lu *et al.*, 2021).

Ao longo dos anos, por diversos motivos, as mulheres vêm optando pela gestação tardia (Mathews; Hamilton, 2002). Segundo o Ministério da Saúde, a gestação em idade avançada é aquela que ocorre após os 35 anos de idade (Brasil, 2012). É conhecido que essa traz riscos tanto para a mãe, quanto para a feto, e, embora os motivos ainda não estejam totalmente esclarecidos, a idade materna avançada se apresenta como um fator de risco para alterações em diferentes parâmetros, como o aumento do peso corpóreo, presença de quadro de dislipidemia, com o aumento dos níveis de triglicerídeos e colesterol, e ao aumento da incidência da diabetes gestacional (Yang *et al.*, 2022).

A intervenção nutricional durante o período pré-concepcional se tornou um consenso global, visto que a adoção de comportamentos saudáveis, como uma boa nutrição e controle do peso corporal materno, pode melhorar a saúde materna e fetal e garantir menos resultados adversos no período durante e pós-gestacional (Benedetto *et al.*, 2024). E, apesar de haver estudos com o uso do antioxidante resveratrol no tratamento da fertilidade de camundongos fêmeas velhas

(Ziętek *et al.*, 2021), até o momento não existem estudos que avaliem o uso pré-concepcional da polpa de açaí sobre parâmetros metabólicos para a mãe em idade avançada, e nem tão pouco sobre o crescimento intrauterino da prole.

Portanto, este trabalho teve como objetivo avaliar se o tratamento pré-concepcional com a polpa de juçara seria seguro sobre parâmetros biométricos, metabólicos, oxidativos e de ninhada de ratas Wistar prenhes saudáveis em idade avançada.

2. REVISÃO DE LITERATURA

2.1 Juçara (*Euterpe edulis Martius*)

A palmeira-juçara (*Euterpe edulis Martius*) é encontrada em diversas regiões do bioma brasileiro Mata Atlântica, presente nos estados do Rio Grande do Norte, Paraíba, Alagoas, Pernambuco, Sergipe, Bahia, Distrito Federal, Goiás, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina e Rio Grande do Sul, além de também estar presente no nordeste da Argentina e no sudoeste do Paraguai (Godoy, 2022). Ela contém valor comercial e econômico, e, a sua extração pode contar tanto com a polpa de seu fruto quanto com o palmito.

Os frutos da juçara são formados em infrutescências e cada infrutescência pode ter mais de dois mil frutos, sendo estes esféricos com coloração quase preta ou negro-vinosa lúzida quando maduros. O mesocarpo do fruto é carnoso é constituído de tecido parenquimático rico em óleos e pigmentos (Queiroz, 2000) e, por isso, é apreciado pela fauna, servindo de alimento para animais como a jacutinga (*Aburria jacutinga*), veado-bororó (*Mazama bororo*) e queixada (*Tayassu pecari*).

Por seus frutos serem consumidos em épocas de escassez de

alimentos, a palmeira-juçara possui um papel ecológico importante como espécie-chave (Godoy, 2022), e, por conta do extrativismo predatório, é uma espécie em estado vulnerável à extinção de acordo com a União Internacional para Conservação da Natureza e dos Recursos Naturais. Logo, a busca por práticas de manejo sustentável é uma medida essencial para a conservação e manutenção da espécie, ainda mais por ser uma espécie com possível papel econômico por suas propriedades nutricionais.

O pigmento do açaí juçara, a antocianina, assim como outros compostos fenólicos presentes no fruto, são importantes metabólitos secundários para o fruto e para a planta, visto que possuem alta atividade oxidante (Lu *et al.*, 2021) agindo como agentes de defesa frente ao estresse oxidativo. A antocianina e os ácidos fenólicos existentes na juçara fazem parte do grupo dos polifenóis. Sabendo disso, o consumo da polpa da juçara pode ter efeito positivo na saúde humana, estudos já relataram que seu uso melhora condições em animais e humanos não saudáveis como a tolerância à glicose (Oyama *et al.*, 2016) e obesidade (Jamar *et al.*, 2020).

2.2 Reprodução em idade avançada

Ao longo dos anos, é observado a tendência, em mulheres, de adiar a gravidez. Este fato pode estar associado às novas atribuições sociais das mulheres, sua inserção no mercado de trabalho, o objetivo de finalizar seus estudos e ter estabilidade financeira (Mathews; Hamilton, 2002; Yavuz, Taze & Salihoglu, 2021), e, assim, elas acabam optando pela gestação tardia. De acordo com o Ministério da Saúde, a gravidez em idade avançada é aquela que ocorre após os 35 anos de idade (Brasil, 2012).

A idade materna avançada se apresenta como um fator de risco para alterações em diferentes parâmetros, como o aumento do peso corpóreo, presença de quadro de dislipidemia, com o aumento dos níveis de triglicerídeos e colesterol, e ao aumento da incidência da diabetes gestacional (Yang *et al.*, 2022). A dislipidemia, principalmente no segundo e terceiro trimestre de gestação, pode ocorrer por conta do aumento da atividade lipolítica nos tecidos adiposos (Alahakoon *et al.*, 2020). Já a diabetes gestacional pode estar relacionada a redução da sensibilidade à insulina conforme a idade e a disfunção de células pancreáticas (Khalil *et al.*, 2013). Além disso, mulheres em idade avançada podem apresentar diminuição da função reprodutiva, com redução da qualidade e quantidade de oócitos, disfunções uterinas e placentárias, e, devido a isso, possuem maiores riscos de efeitos adversos durante a gravidez (Secomandi *et al.*, 2022).

Estudos demonstram que as alterações observadas em mulheres com a idade materna avançada se relacionam com riscos maternos e fetais no período durante e pós-gestacional. Como exemplo, os níveis de HDL e triglicerídeos no sangue materno possuem relação com o menor ou maior peso do feto no momento do nascimento, além da incidência de casos de hipertensão materna induzida pela gravidez (Wu *et al.*, 2019; Xiao; Zhang, 2020). Junto a isso, o ganho de peso materno inadequado durante a gestação se relaciona com a incidência de nascimentos prematuros e a casos de macrosomia (Lin *et al.*, 2019).

2.3 Nutrição materna no período pré-concepcional

Em 2013, houve um consenso mundial para reduzir as taxas de mortalidade maternas e de recém-nascidos. Para isso, o cuidado pré-concepcional começou a receber mais atenção. Este inclui a mudança de comportamentos

médicos, sociais e de estilo de vida, incluindo uma boa nutrição e controle do peso corporal materno. Com o cuidado pré-concepcional, a adoção de comportamentos saudáveis traria benefícios a progênie por ser um período de “janela de oportunidade” crítica para melhorar a saúde materna e fetal (Benedetto *et al.*, 2024). Além disso, o cuidado pré-concepcional também pode significar um preparo materno para mães que planejam ter filhos em idade avançada.

A nutrição materna é importante para o desenvolvimento intrauterino do feto, visto que esta garante energia e nutrientes necessários para o seu crescimento e desenvolvimento. Logo, dependendo da dieta materna, ela pode induzir a modificações epigenéticas associadas a complicações de saúde na prole. Sabe-se que o consumo de polifenóis na dieta pode melhorar a dislipidemia e a resistência à insulina (Arola-arnal *et al.*, 2013). Junto a isso, os polifenóis conseguem atravessar a barreira placentária, e apresentar possíveis benefícios para a prole. No entanto, pouco se sabe sobre o papel dos polifenóis na idade materna avançada, e este conhecimento se faz importante já que o envelhecimento materno contribui para resultados adversos na gravidez (Nacka-aleksc *et al.*, 2022).

De fato, estudos demonstram que o uso do antioxidante resveratrol antes da gestação em camundongos fêmeas velhas pode trazer benefícios para a fertilidade (Ziętek *et al.*, 2021). Entretanto, até onde sabemos, não existem estudos que avaliem se o uso pré-concepcional da polpa de açaí traria benefícios metabólicos para a mãe em idade avançada, ou ainda se poderia interferir com o crescimento intrauterino da prole.

3. ARTIGO CIENTÍFICO

Para fins de apresentação, este trabalho foi redigido na forma de artigo científico em língua inglesa. O formato escolhido foi para a submissão à revista Archives of Physiology and Biochemistry (<https://www.tandfonline.com/action/authorSubmission?show=instructions&journalCode=iarp20>).

Original research article

Title: Preconceptional treatment with açai juçara (*Euterpe edulis* Martius) in advance-aged rats: evaluation of metabolic, oxidative and litter parameters in pregnancy

Mayra Dias Rodrigues¹, Graziela Scaliani Ceravolo¹

¹Laboratorio de Farmacologia Vascular, Departamento de Ciências Fisiológicas, Centro de Ciências Biológicas, Universidade Estadual de Londrina.

Corresponding author: Departamento de Ciências Fisiológicas, CCB-UEL-Campus Universitário, 86051-980-Londrina-PR, Brazil. Tel.: 55 43 33714307; fax: 55 43 33714467. e-mail address: gsceravolo@uel.br (Graziela. S. Ceravolo).

1. Introduction

The juçara palm (*Euterpe edulis* Martius) is a tree native to the Atlantic Forest and the juçara fruit has been studied for being a natural product with compounds beneficial to health such as vitamins, dietary fiber, and its main pigment, anthocyanin, beyond phenolic compounds present in the fruit, contains antioxidant properties (Lu *et al.*, 2021).

The treatment with juçara pulp improves conditions in unhealthy animals and humans, like glucose tolerance (Oyama *et al.*, 2016) and obesity (Jamar *et al.*, 2020). Also, it has been described that another açai species (*Euterpe oleracea* Martius) supplementation demonstrates a protective effect on maternal metabolism and offspring, protecting from fetal growth restriction (da Silva *et al.*, 2020). Plus, antioxidants maintain a balanced oxidative stress that allows an adequate development of the fetus (Anto *et al.*, 2018) and can reduce oxidative stress, in addition to prevent cellular damage (Pisoschi; Pop, 2015), possibly improving metabolism alterations.

Over the years, for many reasons like increased employment opportunities and economic freedom (Yavuz, Taze & Salihoglu, 2021), women have been opting to

postpone pregnancy. According to the Ministry of Health of Brazil (2012), it is considered pregnancy at an advanced age after 35 years old and its occurrence doubled from 7,6% to 16,2% between 1994 and 2019 (Gama *et al.*, 2021). The risks of pregnancy loss, chromosomal abnormalities, fetal growth restriction, pre-eclampsia, gestational diabetes, and cesarean sections increase when increasing the maternal age (Frick, 2021).

In 2013, the concept of pre-conceptional care emerged to reduce the rates of maternal and fetal mortality (Benedetto *et al.*, 2024). Knowing that the maternal nutrition is important to guarantee the nutrients and energy for the growth and development of the fetus (Arola-arnal *et al.*, 2013), the preconception care includes behavioral changes of the mother such as good nutrition and body weight control that can be beneficial to the health of the mother and her progeny (Benedetto *et al.*, 2024). The changes in health habits can also mean a preparation for the women who chose to be pregnant at an advanced age, being a possible safe method in the preconceptional period.

The anthocyanin and phenolic acids existent in juçara belong to the group of polyphenols (Cardoso *et al.*, 2018). The diet of polyphenols is still controversial because its consumption in excess during pregnancy can present adverse outcomes by impair reproductive function and fetal health (Silva *et al.*, 2019). However, polyphenols have important antioxidant activities and it is well-known the benefits of their consumption in diseases like cancer, diabetes and cardiovascular diseases (Ly *et al.*, 2015). Beyond that, anthocyanin consumption presents an improvement in the antioxidant capacity and lipid levels in aged rats (Li *et al.*, 2019).

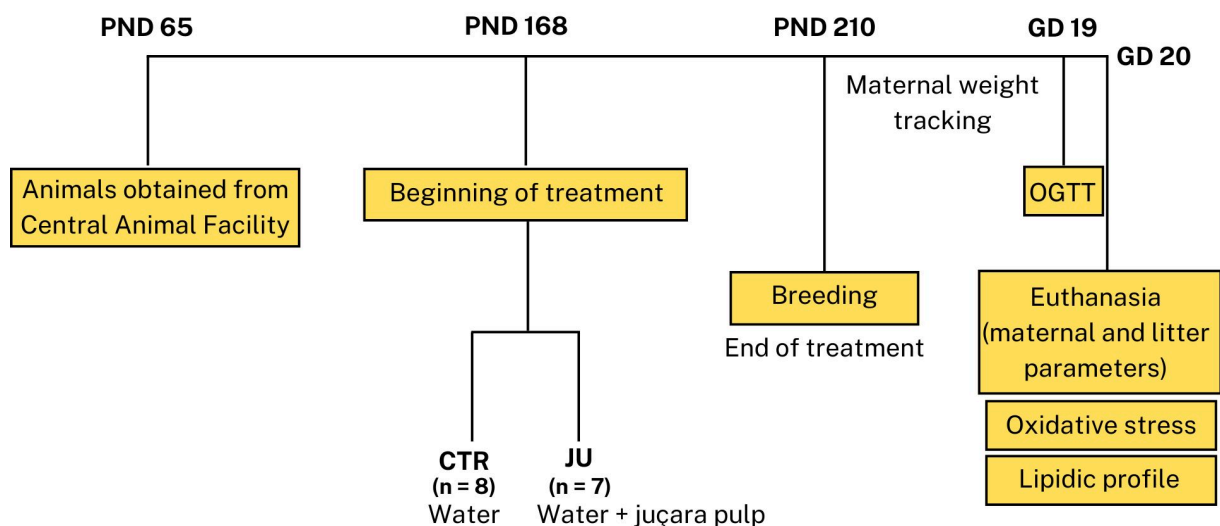
Until now, it is not known if the preconceptional treatment with açai juçara would affect parameters in health-aged females. So the aim of this study was to evaluate the effects of the juçara pulp treatment, before the gestational period, on the biometric, metabolic, oxidative and litter parameters of healthy pregnant Wistar rats at an advanced age.

2. Materials and methods

2.1 Animals and treatment

All animal procedures (Figure 1) were approved by the Animal Research Ethics Committee (CEUA), protocol nº 33/2022. Fifteen female Wistar rats were obtained from the Central Animal Facility and, later, for breeding, twenty male Wistar rats, both sixty-five days old. The animals were kept in collective cages in the vivarium of the Department of Physiological Sciences of the State University of Londrina, in controlled conditions, with air exhaust, at a temperature of 21 ± 2 ° C and 12 h of light/dark (lights on at 6:00 am and off at 6:00 pm) with free access to food (Nuvilab, Colombo, Brazil) and water.

Figure 1 – Experimental design.



CTR (Control group), JU (Juçara group). GD: Gestational day; OGTT: Oral glucose tolerance test; PND: Postnatal day.

The females were kept under the conditions described until PND 168, which corresponds to advanced age in terms of reproduction, considering the significant decrease in fertility observed from 6 months of age (Matt *et al.*, 1986). This age range corresponds to an age analogous in humans between 20-30 years, a mature adult, and 38-47 years, a middle-aged adult (Tong *et al.*, 2024).

On PND 168, the female Wistar rats were randomly assigned into one of the two groups receiving tap water (control group) or juçara pulp (juçara group). The animals from the juçara group were treated for 6 weeks, following the study by Santamarina *et al.* (2018), using a dose of 4.45 g/kg/day by gavage. The dosage was established based on a previous study with açai under reproductive parameters

(Lane *et al.*, 2021), adjusting the dose for Wistar rats, considering the recommendations for consumption of phenolic compounds according to the Food and Drugs Administration (FDA) and the Guide to safe doses for trials initial clinicians (2005). Finally, according to the Brazilian food guide, the chosen dose, corresponding to approximately 50 g of fresh juçara pulp for a 70 kg human, complies with the guidelines of the Ministry of Health and its guidelines regarding fruit consumption (Brasil, 2014). To adjust the amount of pulp administered per day, body weight was assessed weekly.

After the period of treatment (PND 210), females were allocated overnight to breeding with males (one male and one female per cage) until a positive pregnancy diagnosis was confirmed by the presence of sperms in vaginal smears. The males were euthanized, and the females were then kept in individual cages until the beginning of the experiments.

2.2 Maternal weight tracking

The body weight of the pregnant female rats was recorded weekly from the first gestational day until the day of euthanasia.

2.3 Oral glucose tolerance test

To evaluate the tissue's ability to uptake glucose, the oral glucose tolerance test (OGTT) was performed. Food was removed at 7 am and the pregnant female rats were kept under food restriction for 3 hours. After that, basal blood glucose was measured using a glucometer (Accu-Check, Brazil) through a cut on the tail of the pregnant rats. This measurement was considered as the analysis at time 0, or basal glycemia. Then, a 25% glucose solution (0.8ml/100g) was administered by gavage and blood glucose levels were measured at 15 min, 30 min, 60 min, and 120 min, from which a glucose uptake curve was obtained and the area under the curve (AUC) was calculated for comparison between the groups.

2.4 Maternal and litter parameters

On gestational day 20, the pregnant rats were weighed, and euthanasia was performed using thiopental (40 mg/kg). The blood was collected from the left ventricle of the heart and centrifuged at 3500 rpm for 20 minutes at 4°C to obtain the serum. The liver, retroperitoneal, and brown adipose tissue were collected and weighed. For

biometric parameters evaluation, the weights were normalized for g/100g. The caudate lobe of the liver and the serum were stored at -80°C until use. Also on GD 20, a cesarean section was performed, and the litter of which mother was taken from the uterus, weighed and counted, and then euthanized.

2.5 Biomarkers of oxidative stress

Based on Ogo *et al.* (2023), the caudate lobe of the liver was separately homogenized in 1mL of phosphate-buffered saline (PBS) and centrifuged at 3500g for 10 min at 4 C. Then, through the Bradford method, the protein quantification was determined by using bovine serum albumin as the standard (Bradford, 1976). The biomarkers of oxidative stress were measured through the homogenate of the samples, diluted to 1 mg of protein/ml¹.

2.5.1 Carbonyl protein

The quantification of carbonylated proteins modified by the addition of carbonyl groups was performed following the study of Rezmick and Packer (1994). Two stands with micro tubes of 1.5mL were used, where in one stand aliquots of the homogenate were first incubated with 2,4-dinitrophenylhydrazine (DNPH) and the other with hydrochloric acid (HCl), which represented the control, for one hour, and then with trichloroacetic acid (TCA) 28% for 10 min. The samples were centrifuged twice and the supernatants were discarded. At the end, it was added guanidine 6M, incubated for 15 min at 37°C , and then each sample was pipetted on a 96-Well microplate. The plate was read at 385 nm and the results were expressed as nmol/mg.

2.5.2 Products of lipoperoxidation

Measurements of the products of lipoperoxidation were determined through the presence of Thiobarbituric Acid Reactive Substances (TBARS) and malondialdehyde (MDA). The protocols were based on Oliveira and Cecchini (2020) and on Gutteridge (1986). For the preparation of the sample of TBARS, it was added an aliquot of the homogenate to a 96-Well microplate plus the following substances: ferric chloride, ascorbic acid, TCA 28% and thiobarbituric acid (TBA) 1%. The samples were left in a water bath at 90°C for 15 min, and later were immediately left in an ice bath for 5 min. Two readings of the reaction were performed at 535 and 572

nm, disregarding the reading at 535 nm later in the calculation. The results were expressed as $\mu\text{M}/\text{mg}$.

For MDA, an aliquot of the sample protein was added in TCA 28%, and centrifuged. Then, the samples were added to a microplate and incubated with TBA 1% for 30 min at 45°C. The reading was performed at 532 nm and the results were expressed as $\mu\text{M}/\text{mg}$.

2.5.3 Superoxide dismutase

The activity of the antioxidant superoxide dismutase (SOD) was evaluated according to the method proposed by Zhang *et al.* (2016). The principle of this analysis was to quantify the complex formed between superoxide and nitroblue tetrazolium (NBT). Samples that contained the homogenate and different solutions including NBT, EDTA (Ethylenediaminetetraacetic acid), hydroxylamine sulfate, and sodium carbonate buffer (pH 10.2) were measured at 560 nm for 3 min with 15 seconds breaks between readings. The one unit of SOD activity was expressed as % of inhibition/U SOD/mg.

2.5.4 Catalase

Catalase activity was determined by the consumption of hydrogen peroxide, according to Aebi *et al.* (1984). Aliquots of the homogenate were added with a solution containing Tris-HCL and hydrogen peroxide. The samples were read at 240 nm for 1 min and the results were expressed as $\mu\text{mol}/\text{H}_2\text{O}_2/\text{min}^{-1}$.

2.5.5 Glutathione transferase

Glutathione s-transferase (GST) catalyzes the conjugation of glutathione (GSH) with the synthetic substrate CDNB (1-chloro-2,4-dinitrochlorobenzene), that have as a product a conjugate detected at 340 nm (Habig, Pabst, & Jakoby, 1976). The assay was performed in a microplate where an aliquot of each sample protein was added in the reaction medium which contained GSH and solutions with CDNB (2mM) and dibasic potassium phosphate (pH 6,5). Five readings were done at 340 nm each 20 seconds for 5 min. The unit activity was expressed as $\mu\text{mol}/\text{min}/\text{mg}$.

2.6 Lipid profile

The lipid profile was measured following the protocols described by de Souza *et al.* (2022). Concentrations of total cholesterol, HDL (high-density lipoprotein) cholesterol (commercial kits, VIDA biotechnology, Belo Horizonte, Brazil), and triglycerides (commercial kits, Laborclin, Pinhais, Brazil) from the serum were determined by using spectrophotometry.

2.7 Statistics analysis

All data were submitted to a descriptive analysis, in which normality and homogeneity of variance were evaluated, with normal and homogeneous distribution. For statistical analysis, the T-test was used, and the level of significance adopted was 5% ($p < 0.05$). For maternal weight tracking, the two-way ANOVA was performed. The results are presented as mean \pm standard error of the mean (SEM), n=number of rats/groups.

3. Results

When evaluating maternal weight gain (Table 1) there was no difference among groups, however, it is notable that the female rats in all groups gained weight during the gestational period.

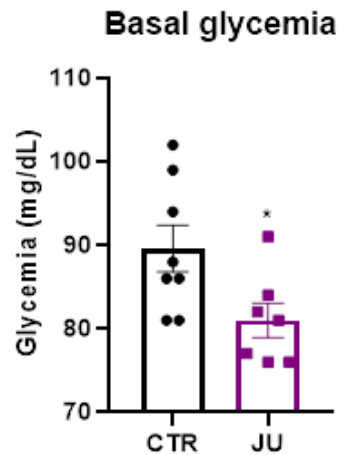
Table 1 – Maternal weight tracking (g) after the treatment period.

Groups	Week one	Week two	Week three
CTR	288,9 \pm 5,50	293,8 \pm 7,13*	323,4 \pm 7,5*
JU	291,9 \pm 11,56	300,7 \pm 11,28*	320,6 \pm 14,85*

Data were expressed as mean \pm SEM, n = 7-8/group. CTR (Control) and JU (Juçara). $p > 0,05$, T-test, * $p < 0,05$, two-way ANOVA, followed by Tukey post-hoc test, *Week one vs Week two vs Week three.

Basal blood glucose (Figure 2) was measured before the glucose overload and after the food restriction period. It is possible to observe that the basal glycemic levels in the pregnant rats of the juçara group were reduced.

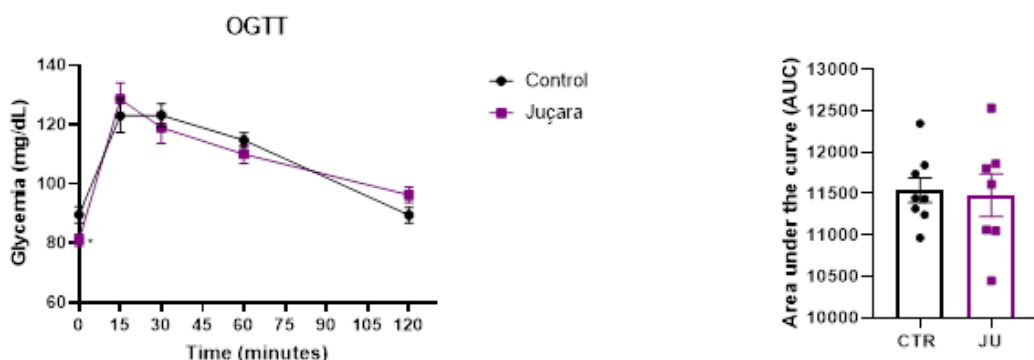
Figure 2 – Basal glycemia (mg/dL) of the different experimental groups.



Data were expressed as mean \pm SEM, n = 7-8/group. CTR (Control) and JU (Juçara), *p<0,05, T-test, *CTR vs JU.

Regarding the glucose tolerance test (Figure 3), there was glucose uptake by the tissues of the pregnant rats from both experimental groups from 15 min, after the glucose overload administration, until 120 min, where the decay of both groups was progressive and closely returning to the values of the basal glycemia. However, there was no difference in the uptake. The area under the curve from the OGTT was obtained for the different groups, also demonstrating no difference in the glucose uptake among them.

Figure 3 – Oral glucose tolerance test (OGTT) of the different experimental groups.



Glucose uptake curve (OGTT): glycemic measurements 15, 30, 60, and 120 min after oral (gavage) glucose administration, and area under the curve (AUC) of the OGTT, n = 7-8/group, p>0,05, T-test, *p<0,05, CTR vs JU. Data were expressed as mean \pm SEM. CTR (Control) and JU (Juçara).

The maternal biometric parameters (Table 2) analyzed included: body weight, retroperitoneal and brown adipose tissue, and liver, measured on the day of the euthanasia. The results showed no statistical difference between the females of the experimental groups.

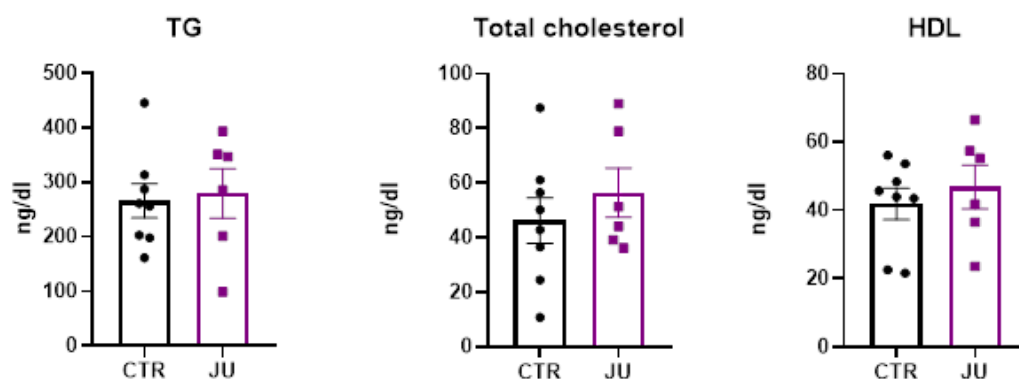
Table 2 – Maternal biometric parameters of the different experimental groups.

Biometric parameters	CTR	JU
Body weight (g)	364.9 ± 12.51	395.3 ± 9.28
Retroperitoneal adipose tissue (g/100g)	0,86 ± 0,096	0,70 ± 0,049
Brown adipose tissue (g/100g)	0,19 ± 0,0230	0,16 ± 0,0068
Liver (g/100g)	4,1 ± 0,092	4,2 ± 0,210

Data were expressed as mean ± SEM, n = 6-8/group. CTR (Control) and JU (Juçara), p>0,05, T-test.

Maternal lipid profile, which included the measurements of the TG, total cholesterol and HDL serum levels were similar among the mothers from the control and juçara groups (Figure 4).

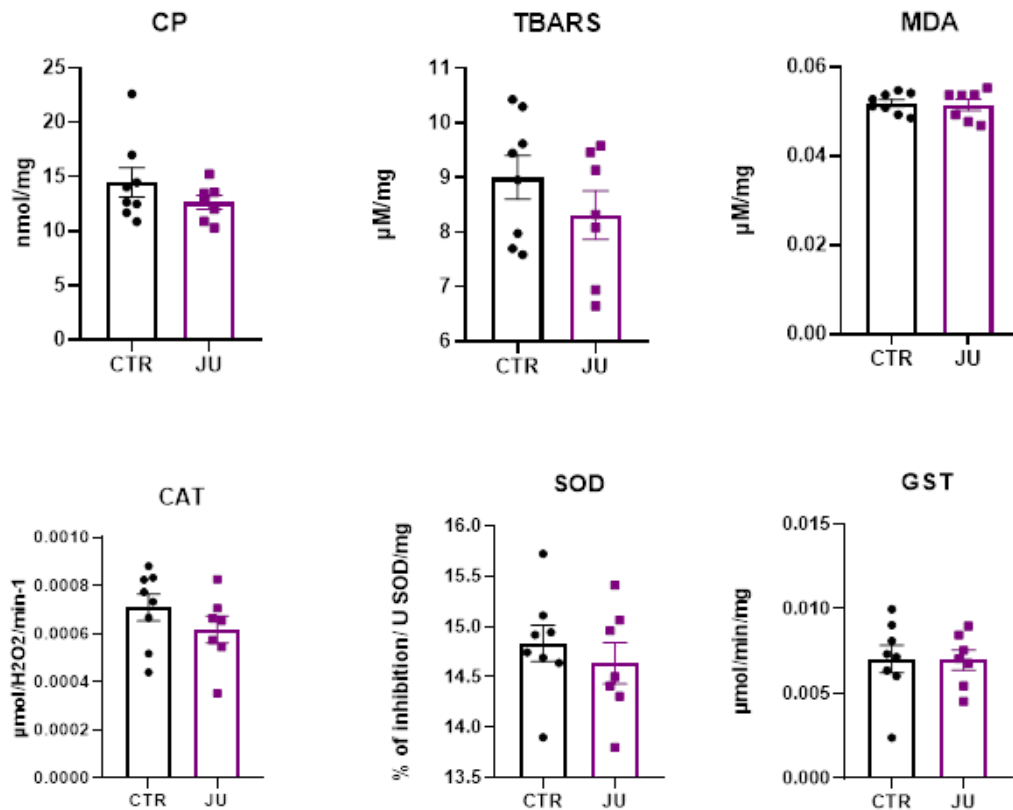
Figure 4 – Maternal lipid profile of the different experimental groups.



Data were expressed as mean ± SEM, n = 6-8/group. CTR (Control) and JU (Juçara), p>0,05, T-test. HDL: High-density lipoprotein cholesterol; TG: triglycerides.

The hepatic oxidative status evaluated here by the measurements of the products of membrane oxidation (MDA and TBARS) and enzyme antioxidant capacity (SOD, CAT and GST), was similar among the pregnant rats of the control and juçara groups, as demonstrated in Figure 5.

Figure 5 – Maternal biomarkers of oxidative stress in the liver.



Data were expressed as mean \pm SEM, n = 7-8/group. CTR (Control) and JU (Juçara), p>0,05, T-test. CAT: catalase; CP: carbonyl protein; GST: glutathione transferase; MDA: malondialdehyde; SOD: superoxide dismutase; TBARS: thiobarbituric acid reactive species.

The litter parameters (Table 3) measured on the day of the euthanasia, where the litter of each mother was individually weighed and counted, presented no difference among the groups.

Table 3 – Litter size and weight of the different experimental groups.

Groups	Litter weight (g)	Litter size
CTR	2,640 ± 0,6020	6-13
JU	1,485 ± 0,2206	6-15

Data were expressed as mean ± SEM for the litter weight. Litter size: range from the minor to the major number of pups per litter, n = 6-8/group. CTR (Control) and JU (Juçara), p>0,05, T-test.

4. Discussion

The present study demonstrated that juçara pulp reduced basal blood glucose levels but did not interfere with biometric, metabolic, and oxidative parameters of healthy-aged pregnant female rats and their litter weight and size. As far as we know, this is the first study to evaluate the preconceptional açai juçara treatment in health-aged pregnant rats. A diet rich in polyphenols during pregnancy can be controversial for maternal and fetal health (Ly *et al.*, 2015). However, the results obtained here suggest that the treatment with açai juçara in the preconceptional period can be safe for the mother and their progeny.

In this study, juçara pulp treatment did not change body weight during pregnancy, although the pregnant rats of all groups gained weight as expected. The body weight on the day of euthanasia also didn't change, as well as the weight of adipose tissues and liver. It is expected to gain weight during a pregnancy, however an excessive maternal weight gain can be related with an abnormal adipose tissue accumulation (Paredes *et al.*, 2021). Here, these parameters remained unchanged, despites in overweight women the body fat was reduced with açai pulp treatment (Pereira *et al.*, 2015). Shekhar (2015) described that the liver size remains unchanged during pregnancy, and is has also been described that, like it was observed here, the supplementation with açai or açai seed extract on young pregnant rats don't interfere in the liver weight, maternal weight gain, body weight either (Barbosa *et al.*, 2021; Bem *et al.*, 2014; da Silva *et al.*, 2020). This shows that the preconceptional treatment with juçara is not harmful for the biometric parameters of healthy pregnant rats.

The basal glycemia was reduced in the juçara group, although the OGTT and AUC remained unaffected in the treated groups. In young pregnant rats, treatment with another plant species with similar compounds to those found in açai, improved the glucose uptake (Lokman *et al.*, 2019). Beyond that, the pigment of the açai juçara, anthocyanin, have shown anti-diabetic effects by also improving glucose uptake (Takikawa *et al.*, 2010). However, in agreement with our study, Silva *et al.* (2020) described no relation between açai consumption and glucose levels in healthy women aged 31-40 years old. In regards to the basal glycemia, agreeing with this study, overweight pregnant women treated with a combination of antioxidants presented reduced fasting glucose (Malvasi *et al.*, 2017), as well as healthy overweight adults treated with açai (Udani *et al.*, 2011). The glucose availability is essential to the organism since the glucose participates in the biosynthesis of ATP (adenosine triphosphate), but improved levels of basal glycemia can reduce the risk of the development of diabetes (Udani *et al.*, 2011), which could mean that the treatment with antioxidants can be advantageous for this parameter. Here, the açai juçara reduced the basal glucose levels but did not affect the tissue's ability to uptake glucose, which could confirm the safety in the consumption of this pulp for the glucose metabolism.

Also, the treatment with juçara pulp did not affect the lipid profile of the pregnant Wistar rats. The same was observed in young female rats where the treatment with açai didn't change the levels of total cholesterol and HDL (de Souza *et al.*, 2010). In health-aged female non-pregnant rats treated with anthocyanin, the levels of total cholesterol and triglycerides were reduced (Li *et al.*, 2019). However, it does not mean a positive effect because the maintenance of total cholesterol levels is important for biological activities, being one of the components of cell membranes and a precursor in biosynthesis of steroids hormones and bile acids (Cerqueira *et al.*, 2016). This study showed the safety of the preconceptional juçara treatment on lipid metabolism.

Reactive oxygen species (ROS) are important in the cell's environment since they are involved with intracellular signaling and other physiological processes (Zhang *et al.*, 2022). So the excess of antioxidant molecules can be detrimental for them because polyphenols act directly as a scavenger of free radicals (Ly *et al.*, 2015). Here, the juçara pulp did not interfere with the biomarkers of oxidative stress

in the liver of the aged pregnant rats, demonstrating that treatment probably did not interfere with the intracellular signaling dependent of ROS. Young female rats treated with açai also did not have alterations in the serum carbonyl protein and SOD activity (de Souza *et al.*, 2010), in liver TBARS (Guerra *et al.*, 2011), as well as in pregnant rats MDA (Barbosa *et al.*, 2021) hepatic levels. As far as we know, there are no studies that analyze the GST activity in female rats treated with açai, in Barbosa *et al.* (2021) the total glutathione content (GSH) did not change with the treatment in healthy pregnant rats. The açai juçara, despites having a rich composition of antioxidant compounds, can maintain the normal antioxidant capacity of the liver.

The consumption in excess of polyphenols can affect fetal ductal constriction and the anatomy and function of the hearth (Ly *et al.*, 2015). This study showed that the maternal preconceptional treatment with juçara did not interfere with the litter size and weight. In agreement with these results, treatments with juçara powder (Morais *et al.*, 2014) or açai seed extract (Silva *et al.*, 2020) also had no effect on the offspring weight and number of healthy mothers. However, a study shows the protective effect that açai compounds extract has in hypertensive pregnant rats and their offspring. Silva *et al.* (2020) described that açai seed extract prevented the reduced litter size and weight in hypertensive mothers, demonstrating the protective effect of açai in this situation. Here, in healthy mothers with advanced age, the treatment was safe for the litter parameters evaluated.

Differences observed here from previous studies can be related to the species used as a source of antioxidants, the doses administered, and the models chosen. A limitation existents in this study is that the parameters evaluated here were measured after the gestational period, which implies that the juçara pulp was no longer present in the blood circulation, so it's not possible to know if the maintenance of the juçara pulp treatment during pregnancy would bring no harmful effects either for both the mother and the fetus. The absence of information about the pre-pregnancy consumption of the açai juçara in health-aged rats is also presented as a limitation. However, this study brings novelty about the safety of juçara pulp in the preconceptional period, suggesting that this nutritional component can be ingested by aged women during this period.

5. Conclusion

In summary, this study demonstrated that the juçara pulp treatment before the gestational period can reduce the basal glucose blood levels, but brings no harm to the other metabolic, biometric and oxidative parameters of healthy pregnant Wistar rats at an advanced maternal age and their offspring, which suggest that the nutritional intervention with juçara pulp can be secure for women in preparation to pregnancy at an advanced age.

References

- Aebi H, 1984. Catalase in vitro. *Methods Enzymol.* 105, 121-126. doi: 10.1016/s0076-6879(84)05016-3.
- Arola-Arnal A, Oms-Oliu G, Crescenti A, del Bas JM, Ras MR, Arola L, Caimari A, 2013. Distribution of grape seed flavanols and their metabolites in pregnant rats and their fetuses. *Mol Nutr Food Res.* 57(10):1741-1752. doi: 10.1002/mnfr.201300032.
- Anto *et al.*, 2018. Adverse pregnancy outcomes and imbalance in angiogenic growth mediators and oxidative stress biomarkers is associated with advanced maternal age births: A prospective cohort study in Ghana. *PLoS ONE*, 13 (7). Doi: 10.1371/journal.pone.0200581.
- Barbosa *et al.*, 2021. Açai (Euterpe oleracea Martius) supplementation improves oxidative stress biomarkers in liver tissue of dams fed a high-fat diet and increases antioxidant enzymes' gene expression in Offspring. *Biomedicine and pharmacotherapy*, 139. DOI: 10.1016/j.biopha.2021.111627.
- Bem *et al.*, 2014. Protective effect of Euterpe oleracea Mart (açai) extract on programmed changes in the adult rat offspring caused by maternal protein restriction during pregnancy. *Journal of Pharmacy and Pharmacology*, 66 (9), 1328-1338. Doi: 10.1111/jphp.12258.
- Benedetto C, Borella F, Divakar H, O'Riordan SL, Mazzoli M, Hanson M, O'Reilly S, Jacobsson B, Conry JA, McAuliffe FM, 2024. FIGO Committee on Well Woman Healthcare, FIGO Committee on the Impact of Pregnancy on Long-Term Health. FIGO Preconception Checklist: Preconception care for mother and baby. *Int J Gynaecol Obstet.* 165(1):1-8. doi: 10.1002/ijgo.15446.
- Bequer *et al.*, 2018. Experimental diabetes impairs maternal reproductive performance in pregnant Wistar rats and their offspring. *Systems Biology in Reproductive Medicine*, 64 (1), 60-70. Doi: 10.1080/19396368.2017.1395928.
- Bradford, M. (1976). A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. *Analytical Biochemistry*, 72, 248–254. <https://doi.org/10.1006/abio.1976.9999>.
- Brasil, 2012. *Gestação de alto risco: manual técnico* [online]. 5. ed. Brasília, Ministério da Saúde. Available from: https://bvsms.saude.gov.br/bvs/publicacoes/manual_tecnico_gestacao_alto_risco.pdf.
- Cardoso AL, de Liz S, Rieger DK, Farah ACA, Kunradi Vieira FG, Altenburg de Assis MA, Di Pietro PF, 2018. An Update on the Biological Activities of Euterpe edulis (Juçara). *Planta Med.* 84(8):487-499. doi: 10.1055/s-0044-101624.

Cerqueira NM, Oliveira EF, Gesto DS, Santos-Martins D, Moreira C, Moorthy HN, Ramos MJ, Fernandes PA, 2016. Cholesterol Biosynthesis: A Mechanistic Overview. *Biochemistry*. 55(39):5483-5506. doi: 10.1021/acs.biochem.6b00342.

Da Silva *et al.*, 2020. Açai (*Euterpe oleracea* Mart) seed extract protects against maternal vascular dysfunction, hypertension, and fetal growth restriction in experimental preeclampsia. *Hypertension in Pregnancy*, 39 (2), 211-219. DOI: 10.1080/10641955.2020.1754850.

De Souza MO, Silva M, Silva ME, Oliveira Rde P, Pedrosa ML, 2010. Diet supplementation with acai (*Euterpe oleracea* Mart.) pulp improves biomarkers of oxidative stress and the serum lipid profile in rats. *Nutrition*, 26(7-8). doi: 10.1016/j.nut.2009.09.007.

De Souza *et al.*, 2022. Glucocorticoids contribute to metabolic and liver impairments induced by lactation overnutrition in male adult rats. *Frontiers in Physiology*, 14. Doi: 10.3389/fphys.2023.1161582.

Frick, 2021. Advanced maternal age and adverse pregnancy outcomes. *Best Practice and Research: Clinical Obstetrics and Gynaecology*, 70, 92-100. Doi: 10.1016/j.bpobgyn.2020.07.005.

Gallo *et al.*, 2012. Pregnancy in aged rats that were born small: Cardiorenal and metabolic adaptations and second-generation fetal growth. *FASEB Journal*, 26 (10), 4337-4347. Doi: 10.1096/fj.12-210401.

Gama *et al.*, 2021. A population-based study of the relationship between advanced maternal age and premature/early-term birth in Brazil. *International Journal of Gynecology and Obstetrics*. Doi: 10.1002/ijgo.14057.

Guerra JF, Magalhães CL, Costa DC, Silva ME, Pedrosa ML, 2011. Dietary açai modulates ROS production by neutrophils and gene expression of liver antioxidant enzymes in rats. *J Clin Biochem Nutr*, 49(3), 188-94. doi: 10.3164/jcbrn.11-02.

Guia Alimentar para População Brasileira promovendo a alimentação saudável, 2014. *Normas e manuais técnicos*. Brasília: Ministério da Saúde.

Gutteridge JM, 1986. Aspects to consider when detecting and measuring lipid peroxidation. *Free Radic Res Commun*. 1(3), 173-84. doi: 10.3109/10715768609083149.

Habig, W. H., Pabst, M. J., & Jakoby, W. B. (1976). Glutathione Stransferase AA from rat liver. *Archives of Biochemistry and Biophysics*, 175, 710–716. [https://doi.org/10.1016/0003-9861\(76\)90563-4](https://doi.org/10.1016/0003-9861(76)90563-4).

Jamar *et al.*, 2020. Effects of the juçara fruit supplementation on metabolic parameters in individuals with obesity: a double-blind randomized controlled trial. *Journal of Nutritional Biochemistry*, 83. Doi: 10.1016/j.jnutbio.2020.108430.

Lane *et al.*, 2021. Increased systemic antioxidant power ameliorates the aging-related reduction in oocyte competence in mice. *International Journal of Molecular Sciences*, [S. I.], 22 (23). DOI: 10.3390/ijms222313019.

Li J, Zhao R, Zhao H, Chen G, Jiang Y, Lyu X, Wu T, 2019. Reduction of Aging-Induced Oxidative Stress and Activation of Autophagy by Bilberry Anthocyanin Supplementation via

the AMPK-mTOR Signaling Pathway in Aged Female Rats. *J Agric Food Chem*, 67(28):7832-7843. doi: 10.1021/acs.jafc.9b02567.

Lin J, Fu Y, Han Q, Yan J, Chen R, Zhang H, 2019. Gestational weight management and pregnancy outcomes among women of advanced maternal age. *Exp Ther Med*, 18(3):1723-1728. doi: 10.3892/etm.2019.7752.

Lokman EF, Saparuddin F, Muhammad H, Omar MH, Zulkapli A, 2019. *Orthosiphon stamineus* as a potential antidiabetic drug in maternal hyperglycemia in streptozotocin-induced diabetic rats. *Integr Med Res*, 8(3):173-179. doi: 10.1016/j.imr.2019.05.006.

Lu W, Shi Y, Wang R, Su D, Tang M, Liu Y, Li Z., 2021. Antioxidant Activity and Healthy Benefits of Natural Pigments in Fruits: A Review. *International Journal of Molecular Sciences*. 22(9). <https://doi.org/10.3390/ijms22094945>.

Ly C, Yockell-Lelièvre J, Ferraro ZM, Arnason JT, Ferrier J, Gruslin A, 2015. The effects of dietary polyphenols on reproductive health and early development. *Hum Reprod Update*. 21(2):228-248. doi: 10.1093/humupd/dmu058.

Malvasi A, Kosmas I, Mynbaev OA, Sparic R, Gustapane S, Guido M, Tinelli A, 2017. Can trans resveratrol plus d-chiro-inositol and myo-inositol improve maternal metabolic profile in overweight pregnant patients? *Clin Ter*. 168(4):240-247. doi: 10.7417/T.2017.2013.

Matt *et al.*, 1986. Chronological changes in fertility, fecundity and steroid hormone secretion during consecutive pregnancies in aging rats. *Biology of Reproduction*, [S. I.], 34 (3), 478–487. DOI: 10.1095/biolreprod34.3.478.

Morais, Carina Almeida *et al.*, 2014. Jussara (*Euterpe edulis* Mart.) Supplementation during Pregnancy and Lactation Modulates the Gene and Protein Expression of Inflammation Biomarkers Induced by trans-Fatty Acids in the Colon of Offspring. *Mediators of Inflammation*, 1-11. DOI: <http://dx.doi.org/10.1155/2014/987927>.

Ogo *et al.*, 2023. Gestational exposure to continuous light impairs the development of the female reproductive system in adult Wistar rat offspring. *Birth Defects Research*, 115 (7), 710-721. Doi: 10.1002/bdr2.2161.

Oliveira FJ, Cecchini R, 2000. Oxidative stress of liver in hamsters infected with *Leishmania* (L.) *chagasi*. *J Parasitol*. 86(5), 1067-1072. doi: 10.1645/0022-3395(2000)086[1067:OSOLIH]2.0.CO;2.

Oyama, L. M. *et al.*, 2016. Juçara pulp supplementation improves glucose tolerance in mice. *Diabetol Metab Syndr*, 1-8. DOI: 10.1186/s13098-015-0122-4.

Paredes Solis JM, Perera Perichart O, Estrada Montoya A, Muñoz Reyes E, Espino Y Sosa S, Castillo Ortega V, Bastidas Medina D, Dolores Tolentino M, Martinez Sanchez M, Salazar Nava S, Gutierrez Estrada G, 2021. Gestational Weight Gain Influences the Adipokine-Oxidative Stress Association during Pregnancy. *Obes Facts*. 14(6), 604-612. doi: 10.1159/000518639.

Pisoschi, Aurelia Magdalena; Pop, Aneta., 2015. The role of antioxidants in the chemistry of oxidative stress: A review. *European Journal of Medicinal Chemistry*, [S. I.], 97, 55–74. DOI: 10.1016/j.ejmech.2015.04.040.

- Reznick AZ, Packer L, 1994. Oxidative damage to proteins: spectrophotometric method for carbonyl assay. *Methods Enzymol.* 233, 357-363. doi: 10.1016/s0076-6879(94)33041-7.
- Shashank Shekhar, Gaurav Diddi, 2015. Liver disease in pregnancy, *Taiwanese Journal of Obstetrics and Gynecology*, 54 (5), 475-482. doi:<https://doi.org/10.1016/j.tjog.2015.01.004>.
- Silva DF, Custódio Neto da Silva MA, Rodrigues GM, Vidal FCB, Barbosa MDCL, Oliveira Brito LM, Bezerra GFB, Muniz Filho WE, Borges KRAO, Rosa IG, de Carvalho JOE, Soares Branda O Nascimento MDD, 2020. Açai (*Euterpe oleracea* Mart) Consumption and Prevention of Chronic Diseases: Is There an Association? A Preliminary Study. *ScientificWorldJournal*. doi: 10.1155/2020/5782485.
- Silva LBAR, Pinheiro-Castro N, Novaes GM, Pascoal GFL, Ong TP, 2019. Bioactive food compounds, epigenetics and chronic disease prevention: Focus on early-life interventions with polyphenols. *Food Res Int.* 125. doi: 10.1016/j.foodres.2019.108646.
- Takikawa M, Inoue S, Horio F, Tsuda T., 2010. Dietary anthocyanin-rich bilberry extract ameliorates hyperglycemia and insulin sensitivity via activation of AMP-activated protein kinase in diabetic mice. *J Nutr*,140, 527-33. <http://dx.doi.org/10.3945/jn.109.118216>.
- Tong XY, Hussain H, Shamaladevi N, Norenberg MD, Fadel A, El Hiba O, Abdeljalil EG, Bilal EM, Kempuraj D, Natarajan S, Schally AV, Jaszberenyi M, Salgueiro L, Paidas MJ, Jayakumar AR, 2024. Age and Sex in the Development of Hepatic Encephalopathy: Role of Alcohol. *Biology (Basel)*. 13(4). doi: 10.3390/biology13040228.
- Udani JK, Singh BB, Singh VJ, Barrett ML, 2011. Effects of Açai (*Euterpe oleracea* Mart.) berry preparation on metabolic parameters in a healthy overweight population: a pilot study. *Nutr J.* 10. doi: 10.1186/1475-2891-10-45.
- Yavuz P., Taze M. & Salihoglu O., 2021. The effect of adolescent and advanced-age pregnancies on maternal and early neonatal clinical data. *Journal of Maternal-Fetal and Neonatal Medicine*, 35 (25), 7399-7405. Doi: 10.1080/14767058.2021.1949445.
- Yang X, Jiang R, Yin X, Wang G, 2022. Pre-BMI and Lipid Profiles in Association with the Metabolic Syndrome in Pregnancy with Advanced Maternal Age. *Contrast Media Mol Imaging*, 2022:4332006. doi: 10.1155/2022/4332006.
- Zhang B, Pan C, Feng C, Yan C, Yu Y, Chen Z, Guo C, Wang X, 2022. Role of mitochondrial reactive oxygen species in homeostasis regulation. *Redox Rep.* 27(1):45-52. doi: 10.1080/13510002.2022.2046423.
- Zhang C, Bruins ME, Yang ZQ, Liu ST, Rao PF, 2016. A new formula to calculate activity of superoxide dismutase in indirect assays. *Anal Biochem.* 503, 65-67. doi: 10.1016/j.ab.2016.03.014.

4. CONCLUSÕES

Este trabalho buscou avaliar os efeitos do tratamento pré-concepcional com açaí juçara sobre parâmetros maternos e de ninhada em ratas em idade avançada. Através dos resultados obtidos, inferimos que o tratamento antes da gravidez seria seguro para os parâmetros avaliados, no entanto, estes foram avaliados após o período gestacional, o que implica que a polpa do açaí não estava mais presente no sangue circulante, logo não é possível saber se a manutenção do tratamento durante a gravidez também não teria efeitos prejudiciais para a mãe e sua prole.

Portanto, o tratamento pré-concepcional com a polpa de açaí juçara reduz os níveis de glicemia basal, mas não altera outros parâmetros metabólicos, biométricos e oxidativos de ratas Wistar prenhes em idade avançada, e nem no peso e número de seus filhotes, o que sugere que o tratamento pré-concepcional não traz malefícios para a mãe e sua prole e ainda que a intervenção nutricional neste período pode ser seguro para mães que pretendem adiar a gravidez.

REFERÊNCIAS

Alahakoon TI, Medbury HJ, Williams H, Lee VW. Lipid profiling in maternal and fetal circulations in preeclampsia and fetal growth restriction-a prospective case control observational study. **BMC Pregnancy Childbirth**, v. 20, n. 1, 2020. doi: 10.1186/s12884-020-2753-1.

Arola-Arnal A, Oms-Oliu G, Crescenti A, del Bas JM, Ras MR, Arola L, Caimari A. Distribution of grape seed flavanols and their metabolites in pregnant rats and their fetuses. **Mol Nutr Food Res**. v. 57, n. 10, out. 2013. doi: 10.1002/mnfr.201300032.

Benedetto C, Borella F, Divakar H, O'Riordan SL, Mazzoli M, Hanson M, O'Reilly S, Jacobsson B, Conry JA, McAuliffe FM. FIGO Committee on Well Woman Healthcare, FIGO Committee on the Impact of Pregnancy on Long-Term Health. FIGO Preconception Checklist: Preconception care for mother and baby. **Int J Gynaecol Obstet**. v. 5, n. 1, p. 1-8, abr. 2024 doi: 10.1002/ijgo.15446.

Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Ações Programáticas Estratégicas. Gestação de alto risco: manual técnico. 5. ed. Brasília, DF: **Ministério da Saúde**, 2012. Disponível em: http://bvsms.saude.gov.br/bvs/publicacoes/manual_tecnico_gestacao_alto_risco.pdf.

Godoy, Rossana Catie Bueno de, et al. Juçara (*Euterpe edulis* M.): importância ecológica e alimentícia. **Embrapa Florestas**, Colombo, 2022.

Jamar *et al.*. Effects of the juçara fruit supplementation on metabolic parameters in individuals with obesity: a double-blind randomized controlled trial. **Journal of Nutritional Biochemistry**, v. 83, 2020. Doi: 10.1016/j.jnutbio.2020.108430.

Khalil A, Syngelaki A, Maiz N, Zinevich Y, Nicolaidis KH. Maternal age and adverse pregnancy outcome: a cohort study. **Ultrasound Obstet Gynecol**, v. 42, n. 6, 2013. doi: 10.1002/uog.12494.

Lin J, Fu Y, Han Q, Yan J, Chen R, Zhang H. Gestational weight management and pregnancy outcomes among women of advanced maternal age. **Exp Ther Med**, v. 18, n. 3, p. 1723-1728, 2019. doi: 10.3892/etm.2019.7752.

Lu W, Shi Y, Wang R, Su D, Tang M, Liu Y, Li Z. Antioxidant Activity and Healthy Benefits of Natural Pigments in Fruits: A Review. **International Journal of Molecular Sciences**. v. 22, n. 9, 2021. <https://doi.org/10.3390/ijms22094945>.

Mathews, T. J. & Hamilton, B. E. **Mean age of mother**, 1970-2000. Natl. Vital Stat. Rep. 2002.

Nacka-Aleksić, M.; Pirković, A.; Vilotić, A.; Bojić-Trbojević, Ž.; Jovanović Krivokuća, M.; Giampieri, F.; Battino, M.; Dekanski, D. The Role of Dietary Polyphenols in Pregnancy and Pregnancy-Related Disorders. **Nutrients**, v. 14, n. 24, 2022. <https://doi.org/10.3390/nu14245246>.

Oyama, L. M. *et al.*. Juçara pulp supplementation improves glucose tolerance in mice. **Diabetol Metab Syndr**, p. 1-8, 2016. DOI: 10.1186/s13098-015-0122-4.

Queiroz, M. H. Biologia do fruto, da semente e da germinação do palmitero (*Euterpe edulis* Martius). In: REIS, M. S.; REIS, A. (ed.). *Euterpe edulis* Martius (Palmitero): biologia, conservação e manejo. Itajaí, SC: Herbário Barbosa Rodrigues, 2000. p. 39-59.

Secomandi L, Borghesan M, Velarde M, Demaria M. The role of cellular senescence in female reproductive aging and the potential for senotherapeutic interventions. **Hum Reprod Update**, v. 28, n. 2, p. 172-189, 2022. doi: 10.1093/humupd/dmab038.

Wu Q, Zhang L, Huang L, Lei Y, Chen L, Liang Z, Zhou M, Xu H, Zhou Y, Wang F, Chen D. Second-trimester maternal lipid profiles predict pregnancy complications in an age-dependent manner. **Arch Gynecol Obstet**, v. 299, n. 5, p. 1253-1260, 2019. doi: 10.1007/s00404-019-05094-z.

Xiao Y, Zhang X. Association Between Maternal Glucose/Lipid Metabolism Parameters and Abnormal Newborn Birth Weight in Gestational Diabetes Complicated by Preeclampsia: A Retrospective Analysis of 248 Cases. **Diabetes Ther**, v. 11, n. 4, p. 905-914, 2020. doi: 10.1007/s13300-020-00792-3.

Yang X, Jiang R, Yin X, Wang G, 2022. Pre-BMI and Lipid Profiles in Association with the Metabolic Syndrome in Pregnancy with Advanced Maternal Age. **Contrast Media Mol Imaging**, 2022. doi: 10.1155/2022/4332006.

Yavuz P., Taze M. & Salihoglu O. The effect of adolescent and advanced-age pregnancies on maternal and early neonatal clinical data. **Journal of Maternal-Fetal and Neonatal Medicine**, , v. 35, n. 25, p. 7399-7405, 2021. Doi: 10.1080/14767058.2021.1949445.

Ziętek M, Barłowska K, Wijas B, Szablisty E, Atanasov AG, Modliński JA, Świergiel AH, Sampino S. Preconceptional Resveratrol Supplementation Partially Counteracts Age-Related Reproductive Complications in C57BL/6J Female Mice. **Molecules**, v. 26, n. 7, mar. 2021. doi: 10.3390/molecules26071934.