



REPÚBLICA FEDERATIVA DO BRASIL
MINISTÉRIO DA EDUCAÇÃO
UNIVERSIDADE FEDERAL DO RIO GRANDE - FURG

A Reitora da Universidade Federal do Rio Grande - FURG no uso de suas atribuições e tendo em vista a conclusão do Curso de Pós-Graduação em Engenharia e Ciência de Alimentos em 24 de Julho de 2014, confere o título de

Doutor em Engenharia e Ciência de Alimentos

a

Francisco Roberto da Silva Machado Junior

brasileiro, natural de Rio Grande / RS, nascido a 17 de Fevereiro de 1980, portador da Cédula de Identidade n.º 7072376556 expedida pela Secretaria da Justiça e da Segurança / RS e outorga-lhe o presente Diploma a fim de que possa gozar de todos os direitos e prerrogativas legais.

Rio Grande (RS), 05 de Setembro de 2014.

Francisco R. da S. Machado Junior
Diplomado


Prof. Dr. Cleusa Maria Sobral Dias
Reitora

CONSELHO REGIONAL DE QUÍMICA

13ª. REGIÃO

REGISTRADO EM 21/01/2022

LIVRO Nº 47 AS FLS 10

PROCESSO Nº 64032

CART. PROF. Nº 13303828

UNIVERSIDADE FEDERAL DO RIO GRANDE - FURG
REITORIA
MINISTÉRIO DA EDUCAÇÃO
SECRETARIA DE AVULSOS ACADÊMICOS

Doutor em Engenharia e Ciências de Alimentos

Francisco Roberto da Silva Machado Junior

Curso homologado pelo CNE (Port. MEC 1077, de 31/08/2012,
DOU 13/09/2012, sec. 1, p. 25)

MINISTÉRIO DA EDUCAÇÃO
UNIVERSIDADE FEDERAL DO RIO GRANDE - FURG
REITORIA

Diploma registrado sob nº 016 fls. 004-v do form. P64
por delegação de competência conferida pela portaria nº 139, do
Departamento de Assuntos Universitários, de 16 de novembro de 1976.

Processo nº 27.759

Em 15 de dezembro de 2014.



Rosana Alves da Conceição
Coordenadora de Registro Acadêmico

DECLARAÇÃO

Declaramos que **Francisco Roberto da Silva Machado Jr.**, cadastrado(a) no CPF nº 972.508.720-87, é bolsista vinculado(a) ao Edital de Chamada Pública FAPESC nº 03/2023 – Programa de Fomento à Pesquisa e Inovação em Áreas Estratégicas para Atender a Demanda da Sociedade Catarinense pela Universidade do Estado de Santa Catarina - UDESC e recebe bolsa DCR - B no valor de R\$ 5.200,00/mês (cinco mil e duzentos reais) pelo período de 01/09/2024 a 31/03/2025, com encerramento da vigência previsto para 31/07/2025.

Florianópolis, data da assinatura digital.

Virginia Silva Machado
Gerente de Eventos em CTI
(assinado digitalmente)



Assinaturas do documento



Código para verificação: **0Z75FG2N**

Este documento foi assinado digitalmente pelos seguintes signatários nas datas indicadas:



VIRGINIA SILVA MACHADO (CPF: 097.XXX.229-XX) em 21/03/2025 às 16:58:22

Emitido por: "SGP-e", emitido em 19/02/2021 - 18:08:36 e válido até 19/02/2121 - 18:08:36.

(Assinatura do sistema)

Para verificar a autenticidade desta cópia, acesse o link <https://portal.sgpe.sea.sc.gov.br/portal-externo/conferencia-documento/RkFQRVNDXzQzMDVfMDAwMDI1MTNfMjUxM18yMDI0XzBaNzVGRzJO> ou o site

<https://portal.sgpe.sea.sc.gov.br/portal-externo> e informe o processo **FAPESC 00002513/2024** e o código **0Z75FG2N** ou aponte a câmera para o QR Code presente nesta página para realizar a conferência.



MUNICÍPIO DE CHAPECÓ
Secretaria de Fazenda e Administração

Nota Nº - Série
0000000001 - E

Autenticidade
C9ON-UU0B

NOTA FISCAL ELETRÔNICA DE SERVIÇOS - AVULSA

Data da Emissão: **03/09/2025 12:05:18** Data do Serviço: **03/08/2025**

Competência: **08/2025**



PRESTADOR DE SERVIÇOS

Razão Social: **FRANCISCO ROBERTO DA SILVA MACHADO JR.**
Nome Fantasia:
CNPJ/CPF: **972.508.720-87** IM: IE: TELEFONE: **(49)999647184**
Endereço: **RUA LAURO MULLER - E ,454 ,AP.301 (RESIDENCIAL DOM LUIGI) - SANTA MARIA**
CEP: **89812-214** Cidade: **CHAPECÓ** UF: **SC**
Email: **franciscojr_ea@yahoo.com.br**

TOMADOR DE SERVIÇOS

Razão Social: **FUNDACAO UNIVERSIDADE DO ESTADO DE SC UDESC**
Nome Fantasia:
CNPJ/CPF: **83.891.283/0001-36** IM: IE: TELEFONE: **(48) 3321-8123/ (48)**
Endereço: **AVENIDA MADRE BENVENUTA 2007 ,2007 ,CENTRO - SANTA MONICA**
CEP: **88035-001** Cidade: **FLORIANÓPOLIS** UF: **SC**
Email: **ccon.reitoria@udesc.br**

LOCAL DA PRESTAÇÃO DE SERVIÇO

Cidade: **CHAPECÓ**

DISCRIMINAÇÃO DOS SERVIÇOS

Página 1 de 1

Pagamento de pró-labore pela prestação de serviço do bolsista Francisco Roberto da Silva Machado Jr. , da modalidade DCR-B, para o desenvolvimento de atividades laboratoriais, com carga horária de 120 horas, no período de 01 a 31 de agosto de 2025, na modalidade presencial. SGPe 26993/2025 - IL 1042/2025 - Nota de Empenho: 2025NE005348.

Processo executado por: **172.16.20.60**

Consulte a autenticidade desta Nota através do site:
<https://chapeco.meumunicipio.online/ISS/>

Situação de Tributação do ISSQN
Tributada no Prestador

Código do Serviço
201 - Serviços de pesquisa e desenvolvimento de qualquer natureza

INSS(R\$)	IR(R\$)	PIS(R\$)	COFINS(R\$)	CSLL(R\$)	D.COND/DEDUÇÕES(R\$)
0,00	0,00	0,00	0,00	0,00	0,00

Os valores acima referem-se as retenções de tributos administrados pela União, sendo de responsabilidade do Prestador os dados informados e não implicam na base de cálculo do ISSQN.

D.ICON/OBRAS(R\$)	SUBEMPREITADA(R\$)	BASE DE CÁLCULO(R\$)	ALÍQUOTA(%)	VALOR ISS(R\$)	VALOR TOTAL(R\$)
0,00	0,00	7.240,19	4,0000	289,61	7.240,19

VALOR LÍQUIDO DA NOTA R\$ 7.240,19

Article

A Mixture of Free and Microencapsulated Essential Oils Combined with Turmeric and Tannin in the Diet of Dairy Cows: Effects on Productive Efficiency and Animal Health

Emeline Pizzolatto de Mello ¹, Miklos Maximiliano Bajay ¹ , Tainara Leticia dos Santos ¹, Renato Santos de Jesus ², Guilherme Luiz Deolindo ³ , Luisa Nora ³, Mario Augusto Tortelli ¹, Gilnei Bruno da Silva ³ , Daiane Manica ⁴ , Margarete Dulce Bagatini ⁴, Francisco Machado, Jr. ² and Aleksandro S. da Silva ^{1,2,3,*} 

¹ Programa de Pós-Graduação em Zootecnia, Universidade do Estado de Santa Catarina (UDESC), Chapecó 89815-630, Brazil; emeline@unochapeco.edu.br (E.P.d.M.); miklos.bajay@udesc.br (M.M.B.); 07719519906@edu.udesc.br (T.L.d.S.); mario.torteli0900@edu.udesc.br (M.A.T.)

² Departamento de Zootecnia, Universidade do Estado de Santa Catarina (UDESC), Chapecó 89815-630, Brazil; renato.jesus0026@edu.udesc.br (R.S.d.J.); franciscojr_ea@yahoo.com.br (F.M.J.)

³ Programa de Pós-Graduação Multicêntrico de Bioquímica e Biologia Molecular, Universidade do Estado de Santa Catarina (UDESC), Lages 88520-000, Brazil; guilhermeluizd@outlook.com (G.L.D.); luisa.nora22@gmail.com (L.N.); gilneibrunosilva@gmail.com (G.B.d.S.)

⁴ Centro de Ciências da Saúde, Universidade Federal Fronteira Sul, Chapecó 89815-899, Brazil; daianemanica2011@gmail.com (D.M.); margarete.bagatini@uffs.edu.br (M.D.B.)

* Correspondence: aleksandro.silva@udesc.br

Simple Summary: The increasing use of feed additives aims to increase productivity, but it can also improve cow health. In this study, the inclusion of a phytobiotic additive based on a combination of oregano and cinnamon essential oils (free and microencapsulated) associated with turmeric extract and tannin in the diet of Jersey cows increased milk production and was also capable of increasing milk fat, with an emphasis on a higher proportion of polyunsaturated fatty acids and unsaturated/saturated ratio. The ingestion of the phytoactive by the cows had an anti-inflammatory effect, capable of reducing pro-inflammatory markers, such as acute-phase proteins, but stimulated the production of immunoglobulins. Lower levels of lipid peroxidation and reactive oxygen species indicate that the additive has an antioxidant effect and can reduce and minimize physiological oxidative stress in lactating cows.



Academic Editor: Gabriella Holló

Received: 4 April 2025

Revised: 23 May 2025

Accepted: 26 May 2025

Published: 29 May 2025

Citation: de Mello, E.P.; Bajay, M.M.; dos Santos, T.L.; de Jesus, R.S.; Deolindo, G.L.; Nora, L.; Tortelli, M.A.; da Silva, G.B.; Manica, D.; Bagatini, M.D.; et al. A Mixture of Free and Microencapsulated Essential Oils Combined with Turmeric and Tannin in the Diet of Dairy Cows: Effects on Productive Efficiency and Animal Health. *Animals* **2025**, *15*, 1588. <https://doi.org/10.3390/ani15111588>

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Abstract: This study aimed to evaluate whether the addition of a phytobiotic additive formulated based on cinnamon and oregano essential oils (50% free and 50% microencapsulated) combined with turmeric extract and tannins to the diet of cows has beneficial effects on health, productivity, and milk quality. In a completely randomized design, eighteen Jersey cows were used in a compost barn system over 45 days. The cows were divided into two homogeneous groups: one control (without additive; $n = 9$) and another treatment (with a phytobiotic at a dose of 2 g/cow/day; $n = 9$). The diet was formulated based on corn silage, hay and concentrate for daily 30 L/cow production. Blood and milk samples were collected at 15-day intervals. There was a treatment $\times$ day interaction: cows that consumed the phytobiotic additive produced a more significant amount of milk at days 14, 17, 18, 30, 39 and 45 ($p \leq 0.05$). When we corrected milk production for fat percentage, we observed higher milk production in the cows that consumed phytobiotics compared to the control during the experimental period ($p = 0.01$). The feed intake of cows fed phytobiotics was lower ($p = 0.01$). Thus, feed efficiency was better in cows that consumed phytogenics. There was a higher percentage of fat in the milk of cows that consumed phytobiotics and a higher amount of polyunsaturated fatty acids compared to the control ($p = 0.02$). There was an increase in total protein and globulin levels ($p = 0.01$), which may be associated

with the interaction of the antimicrobial, antioxidant, and immunomodulatory properties of the phytobiotic additive. An increase in immunoglobulins ($p = 0.01$) and a reduction in acute-phase proteins ($p \leq 0.05$) were observed in the blood of cows in the phytobiotic group. Lower levels of TNF- α , IL-1 β and IL-6 and higher levels of IL-10 in the serum of cows that consumed the phytoactive ($p = 0.01$) reaffirm the anti-inflammatory effect of the additive. Lower levels of lipid peroxidation (TBARS) and reactive oxygen species (ROS) were observed in the serum of cows in the phytobiotic group. Greater catalase and superoxide dismutase activity was observed in cows that consumed the phytoactive ($p < 0.01$). Therefore, it can be concluded that the additive in question has antioxidant, immunological, and anti-inflammatory actions and has the potential to improve productive performance when corrected for milk fat.

Keywords: carvacrol; thymol; cinnamaldehyde; curcumin; polyphenols

1. Introduction

Maintaining animal health has become a priority among producers in intensive production systems [1]. The aim is to improve the condition of animals against metabolic diseases, oxidative stress, and immunological challenges that may compromise growth performance as well as the longevity of dairy cows in the face of problems that often require veterinary interventions and the use of anti-inflammatory drugs and antibiotics, which increase production costs, in addition to the likelihood of leading to the development of antimicrobial resistance, a global public health concern. Therefore, the search for alternative and sustainable solutions has gained prominence; among them, phytobiotic additives and compounds of plant origin with functional properties have shown promise [2]. Essential oils (EOs) are recognized as effective natural additives that modulate ruminal fermentation, mitigate methane gas production, increase nutrient digestibility, and contribute to improved production efficiency and ruminant health [2,3]. The microencapsulation of EOs is a technological method that protects bioactive compounds and optimizes their release in the digestive tract of animals, increasing their effectiveness when the objective is absorption [4]. In addition, EOs have antimicrobial and antioxidant actions, modulate ruminal microbiota, and promote greater fermentation efficiency [5].

Curcumin, derived from *Curcuma longa*, is widely recognized for its antioxidant and anti-inflammatory properties, which contribute to reducing oxidative stress and improving liver function in cattle [6]. Tannins, in turn, protect dietary proteins against ruminal degradation, improve feed efficiency, and contribute to the reduction in methane emissions, which makes this synergistic interaction potentially beneficial to animal health and makes the nutrients present in the diet more efficient, in addition to ensuring animal welfare [7]. In this study, we used a combination of cinnamon and oregano EOs in their free and microencapsulated form associated with turmeric extract and tannin, which, in a previous survey of the group, enhanced the weight gain of cattle in confinement [8], unlike another study of ours with a similar additive, the only difference being that the EOs were only in microencapsulated form, with initial positive effects on weight gain that were not maintained throughout the experimental period in the rearing phase [9]. In two studies [8,9], an anti-inflammatory and antioxidant effect was observed, in addition to a hepatoprotective effect, which, according to the authors, may be responsible for enhancing the growth performance of beef cattle. Our hypothesis is that the anti-inflammatory, antioxidant and antimicrobial effects of the components present in the additive will enhance productivity since these known effects of phytoactive improve animal health. Therefore, the aim of

this study was to evaluate whether the addition of a mixture of EOs (free and microencapsulated), combined with turmeric extract and tannin, to the diet of lactating cows had beneficial effects on animal health and metabolism, modulated the immune system, and stimulated the antioxidant response, resulting in improved growth performance of Jersey cows at peak production.

2. Materials and Methods

2.1. Additive

The phytobiotic blend was the Phyto Rumen Plus[®] (Tecphy, Canelinha, Brazil), a trade name for The phytogenic blend contains in its formulation 1/3 of the phytogenic mixture corresponding to the microencapsulated EO of cinnamon (cinnamaldehyde) and oregano (carvacrol and thymol) (a ratio of 50:50), 1/3 non-encapsulated EO of cinnamon and oregano (50:50%) and 1/3 of turmeric extract (4.5–5% curcumin), and tannin. The blend contained 166 mg per concentrate [8], resulting in an average daily intake of 2 g of animal phytogenic compounds. The dose was defined based on previous studies by our research group and respected the commercial indication of the product.

2.2. Characterization of Experimental Environment

The experiment was carried out in the ruminant sector of the Experimental Farm of the Centro de Educação Superior do Oeste (FECEO) of the Universidade do Estado de Santa Catarina (UDESC), located in the city of Guatambu/SC, Brazil. In a compost, barn-type shed with an area of 384 m², with a wood shaving/sawdust bedding area (15.2 m² per cow), a feeding track with individual feeders was used, where each canister contained a cow. A robotic milking system with free access to cows was used in this study, configured to allow up to four milkings per cow per day. In addition, the facility had available smart feeders (Intergado[®], Betim, Brazil) that identified cows and quantified their consumption during the night.

2.3. Animals, Experimental Design and Diet

The experiment involved 18 multiparous Jersey cows, between 21 and 30 days of lactation, divided into two groups of 9 cows each, according to the average milk production in the last 7 days before the experiment (day 1). Prior to the experiment, postpartum cows consumed a diet (corn silage and concentrate) with a low amount of starch in the feeders twice a day and had access to millet pasture, which explains why milk production on day 1 was on average 22.5 kg, reducing in the first seven days (Figure 1), and when there was a change in diet, there was a reduction in consumption (animals were removed from the pasture); feeding was only in the feeders, as described below.

The phytobiotic group received the concentrate with the addition of 2 g/day of the phytobiotic (Phyto Rumen Plus[®], Tecphy, Canelinha, Brazil) via the concentrate in the individual feeder during the two feedings in the morning and afternoon, and the control group received the basal concentrate without the inclusion of the additive. It is important to emphasize that we chose to add additives only to the feedings with controlled quantities to ensure the total consumption of the additive at the scheduled dose of 2 g/cow/day. As there was no leftover feed during the entire experimental period, we can guarantee that 100% of the additive was consumed.

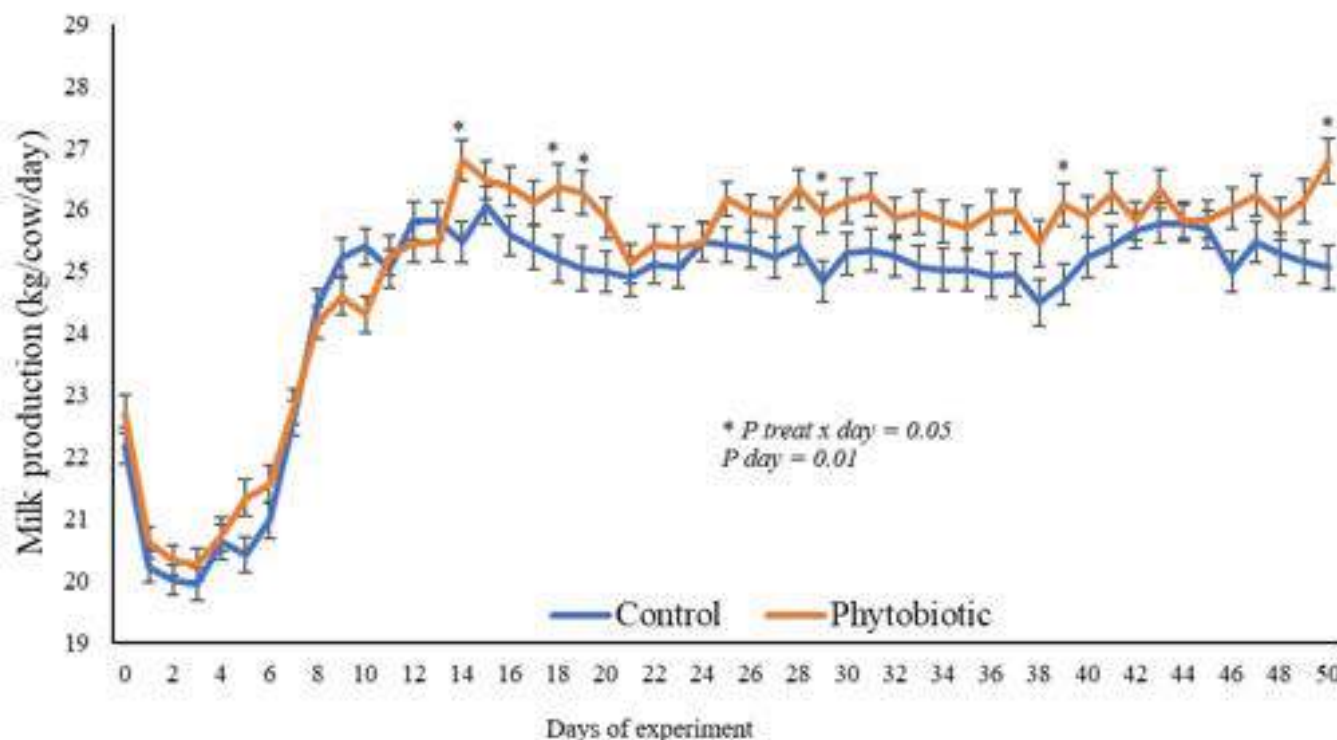


Figure 1. The daily milk production of cows fed phytobiotics compared to cows in the control group. * indicates the difference between groups owing to the treatment $\times$ day interaction.

The diets were formulated according to the nutritional requirements of the NRC [10] for daily 30 L/cow production. The feed was formulated based on corn silage (44.74%), Tifton 85 hay (7.03%), and concentrate (48.23%) provided to the cows in the form of a basal diet (20 kg dry matter intake (DMI), which corresponded to a calculated composition of 16.9% of crude protein/kg DM, and net energy lactation (NEL) of 1.59 Mcal/kg DM (Table 1). During the day, feeding was performed in individual feeders (animals were trapped by a cage for 90 min), with access to water and drinkers between feeders, twice a day (07:00 and 16:00). At night, the cows had access to smart feeders that provided the daily feed intake for each cow (Intergado[®], Ponta Agro, Betim, Brazil), which contained the total diet using the concentrate without additives, as previously mentioned. Water was provided ad libitum, as the cows had access to automatic drinkers spread throughout the facility.

Table 1. Chemical composition and fatty acid content of partial mixed ration (PMR) used in cow feed.

Variable	PMR Control ¹	PMR Phytobiotic ¹	Robot Feed
Dry matter (DM), %	49.7	49.6	92.0
Ash, % DM	7.24	7.11	10.6
Crude protein, % DM	14.0	14.0	21.8
Ethereal extract, % DM	1.21	1.02	5.63
NDF, % DM	19.0	19.2	29.7
Fatty acid, %			
C4:0 (Butyric)	0.55	0.57	-
C6:0 (Caproic)	0.01	1.31	-
C12:0 (Lauric)	0.72	0.70	-
C13:0 (Tridecanoic)	0.20	0.15	-
C14:0 (Myristic)	0.03	0.27	-
C14:1 (Myristoleic)	0.40	0.49	-
C15:0 (Pentadecanoic)	0.16	0.24	-

Table 1. Cont.

Variable	PMR Control ¹	PMR Phytobiotic ¹	Robot Feed
C16:0 (Palmitic)	23.6	24.1	-
C16:1 (Palmitoleic)	2.15	2.08	-
C17:0 (Heptadecanoic)	0.22	0.47	-
C17:1 (cis-10-Heptadecenoic)	0.04	0.07	-
C18:0 (Stearic)	4.22	4.85	-
C18:1n9t (Elaidic)	0.34	0.33	-
C18:1n9c (Oleic)	24.6	24.2	-
C18:2n6c (Linoleic)	39.6	38.8	-
C20:0 (Arachidic)	0.68	0.53	-
C20:1n9 (cis-11-Eicosenoic)	0.25	0.24	-
C18:3n3 (α-Linolenic)	4.20	4.55	-
C21:0 (Heneicosanoic)	0.05	0.03	-
C20:2 (cis-11,14-Eicosadienoic)	0.06	0.03	-
C22:0 (Behenic)	0.61	0.43	-
C20:3n6 (cis-8,11,14-Eicosatrienoic)	0.01	0.02	-
C20:4n6 (Arachidonic)	0.17	0.11	-
C24:0 (Lignoceric)	0.70	0.47	-
C24:1n9 (Nervonic)	0.02	0.07	-

The concentrate used in this diet was formulated based on 34% corn, 42% soybean meal, 5% wheat bran, 12.5% soybean hulls, 1.5% sodium bicarbonate, 4.5% minerals/vitamin supplement, 0.25% urea, and 0.25% myco-toxin adsorbent. The vitamin and mineral supplement had the following guaranteed levels: calcium (min.) 231.40 (g/kg), calcium (max.) 250.00 (g/kg), phosphorus (min.) 40.00 (g/kg), sulfur (min.) 20 (g/kg), magnesium (min.) 25.00 (g/kg), potassium (min.) 10.00 (g/kg), sodium (min.) 70.00 (g/kg), cobalt (min.) 15.00 (mg/kg), copper (min.) 750.00 (mg/kg), copper (min.) 20.00 (mg/kg), iodine (min.) 40.00 (mg/kg), manganese (min.) 2000.00 (mg/kg), selenium (min.) 22.00 (mg/kg), zinc (min.) 2850.00 (mg/kg), vitamin A (min.) 350,000.00 (IU/kg), vitamin D3 (min.) 100,000.00 (IU/kg), vitamin E (min.) 2000.00 (IU/kg). ¹ Partial mixed ration, with only the diet provided in individual feeders/automatic feeders (without robot feed).

A robotic milking system with a free-flow system was used for the cows to be milked; as an attraction for seeking milking, the cows received pelleted feed at each visit, limited to 3 kg/day. Therefore, the following was considered when measuring the dry matter intake (DMI) of the cows: diet in individual feeders (during the day) + diet in automatic feeders (during the night) + robotic concentrate (during milking).

2.4. Data and Sample Collection

The data on the daily feed intake were obtained using a robotic milking system (pelletized feed), an innovative feeder system, and by weighing the leftovers in the individual feeders. Milk production was performed daily using the milking system, allowing the verification of teat production and total milk production. Based on this information, the productive efficiency of the cows was calculated. Milk production corrected for 4% fat (4% FCM) was estimated using the equation proposed by the NRC (2001) [10]: 4% FCM = $0.4 \times (\text{kg of milk produced}) + 15 \times (\% \text{ fat}) \times (\text{kg of milk produced})$.

Blood was collected during the 45 days of the experiment at 15-day intervals, always in the morning (between 7:30 AM and 9:30 AM), before feeding the individual feeders. On the day of collection, all animals were apparently healthy, and no cow was apparently in estrus.

Samples were collected on days 14, 28 and 45 for composition and quality analysis. Milk collection was performed using a robotic milking system, which allows the collection of a homogeneous sample of the entire lactation period of the cow, with the material allocated in tubes (50 mL) containing preservatives (bronopol). The collected material was sent on the same day to a specialized commercial laboratory authorized by the Brazilian federal government.

Milk (50 mL) was collected on day 45 to determine the fatty acid profile. Blood samples were collected in tubes with a clot activator (4 mL) to separate blood serum and in tubes with 10% EDTA anticoagulant (4 mL) for blood count analysis and tubes with sodium citrate for the analysis of antioxidant enzymes in whole blood. After collection, the material was stored in a thermal box with ice (temperature ± 10 °C) until processing within 3 h. The tubes with the clot activator were centrifuged ($820 \times g$ for 10 min), and the serum was collected and stored in microtubes at -20 °C.

Two hundred grams of samples of a partially mixed ration (PMR) supplied in individual and automatic feeders were collected throughout the experiment (days 1, 10, 20, 30 and 45), totaling 1 kg of the PMR that was frozen (-20 °C) until analysis. This material, as well as the robot feed (supplied during milking) collected on the same date as the PMR, were subjected to physical–chemical analyses described below.

2.5. Laboratory Analysis

2.5.1. Chemical Composition of Feed

Initially, the feed samples were partially dried in a forced ventilation oven at 54 °C for 72 h, after which each sample was ground to pass through a 0.5 mm screen using a mill grinder (Retsch zm 200 (Retsch, Haan, Germany), ring sieve size: 0.75 mm) before chemical analysis. For dry matter (DM) evaluation, samples were placed in a forced ventilation oven at 105 °C for 24 h and then weighed. Crude protein quantification was performed using the Kjeldahl method (Method 2001.11), which includes the digestion, distillation, and titration phases [11]. The ash content, which indicates the mineral matter in the samples, was measured by incinerating the samples in a muffle furnace at 600 °C for six hours, eliminating the organic matter and retaining only the ashes, which were weighed to determine the percentage calculation. The ether extract was quantified according to the manufacturer's recommendations using an automatic fat and lipid extractor (SER 158/6 Velp Scientifica®; Usmate Velate, Italy). Finally, neutral detergent fiber (NDF) analysis was performed according to the methods described by researchers [11,12].

2.5.2. Hemogram

Hematological variables were obtained from blood samples collected in tubes with EDTA and analyzed using the automatic hematological analyzer VET3000® (EQUIP, Itatiba, Brazil). This analyzer determines the counts of leukocytes, lymphocytes, granulocytes, monocytes, erythrocytes, and platelets, as well as the concentration of hemoglobin (g/dL) and hematocrit (%).

2.5.3. Serum Biochemistry

Blood samples collected in tubes without anticoagulant were centrifuged in a QUIMIS (São Paulo, Brazil) tube centrifuge for 10 min at $820 g$ to obtain blood serum. The serum was then stored in microtubes at -20 °C until analysis was performed. Serum levels of the total protein, albumin, urea, C-reactive protein, cholesterol, fructosamine, alanine aminotransferase (ALT), aspartate aminotransferase (AST), and gamma-glutamyltranspeptidase (GGT) were determined. For this purpose, Analisa® kits (Gold Analisa Diagnóstica Ltda, Belo Horizonte, Brazil) were used with EQUIPIVET equipment (Zybio EXC-200®, Shenzhen, China). The globulin concentration was calculated using the following equation: total protein—albumin.

2.5.4. Proteinogram and Cytokines

Firstly, the total protein content obtained using the biuret technique was used as a reference for quantification. Sodium dodecyl sulfate–polyacrylamide gel electrophoresis (SDS-PAGE) was performed according to the technique described by Fagliari et al. [13] using

mini-gels (10 × 10 cm) with adaptations made by Tomasi et al. [14]. The gels were stained with Coomassie blue and photographed to identify and quantify the protein fractions using Labimage 1D software (Loccus Biotechnology, São Paulo, Brazil). A standard containing fractions with molecular weights between 10 kDa and 250 kDa (Kaleidoscope, Bio-Rad, Hercules, CA, USA) was used as a reference, using known commercial standards. Analyses were performed in duplicate.

Interleukin 1 β (IL-1 β), IL-6, and IL-10 levels in serum were measured using commercial kits and an enzyme-linked immunosorbent assay device (Awareness Technology, Inc., Palm City, FL, USA; Chem Well; USCN, Wuhan, China). Tumor necrosis factor alpha (TNF- α) in serum was assessed by the ELISA assay using commercial Quantikine immunoassay kits (Abingdon Science Park, Abingdon, UK) according to the manufacturer's instructions.

2.5.5. Oxidative Status

The oxidative status variables evaluated in the blood serum were reactive oxygen species (ROS), thiobarbituric acid-reactive substances (TBARSs), and myeloperoxidase activity (MPO). The analyses were performed in triplicate using specific biochemical methodologies. Color and fluorometric readers were prepared using Varioskan™ LUX (Thermo Scientific™, Waltham, MA, USA).

ROS formation was estimated using a fluorometric protocol established by Ali et al. [15]. Ten microliters of serum were soaked in 10 μ L of 2',7'-dichlorofluorescein diacetate (DCFH-DA, 7 μ M) and 240 μ L of PBS. After 30 min of incubation at 37 °C, the final product of DCFH-DA oxidation, dichlorofluorescein (DCF), was measured. The fluorescence emission intensity was read at an emission wavelength of 525 nm and an excitation wavelength of 488 nm. The results were expressed as a percentage (%) of the fluorescence intensity relative to the control.

Lipoperoxidation is a highly rapid reaction formed by the breakdown of polyunsaturated fatty acids, which are usually measured by their products, mainly TBARSs, among which malondialdehyde (MDA) is the primary product [16]. To evaluate this product, the reaction of thiobarbituric acid (TBA) with serum samples was used, which, in the presence of MDA, resulted in a pink product that could be read at 532 nm. Briefly, 20 μ L of each sample was mixed with 55 μ L distilled water, 100 μ L orthophosphoric acid (0.2 M), and 25 μ L TBA (0.1 M). Spectrophotometric readings were taken after 45 min of incubation at 37 °C. The results are expressed in nanomolar MDA/mL.

MPO is a heme enzyme produced by inflammatory mediators and released from leukocytes at the injury site. Therefore, MPO levels reflect the activation of neutrophils and lymphocytes. MPO catalyzes the reaction of chloride ions with H₂O₂ to generate large amounts of hypochlorous acid (HOCl), which further reacts to generate singlet oxygen and hydroxyl radicals. In the presence of H₂O₂ as an oxidizing agent, MPO catalyzes the oxidative coupling of phenol and 4-aminoantipyrine (AAP), resulting in a colored product, quinoneimine, with a maximum absorbance of 492 nm [17]. MPO activity was analyzed using a modified peroxidase system, with a mixture of 12 μ L of serum sample with 148 μ L of AAP in phenol solution (AAP 2.5 mM; phenol 20 mM) and 17 μ L of H₂O₂ solution (17 mM). After 30 min of incubation at 37 °C, the system was analyzed spectrophotometrically. The results are expressed as μ M quinoneimine per mg of protein produced in 30 min (μ Mq/mg/30 min).

In whole blood collected with sodium citrate, the activity of antioxidant enzymes, catalase (CAT) and superoxide dismutase (SOD), was measured. Prior to enzyme analysis, protein levels were determined by the method of Bradford [18] using bovine serum albumin as a standard. CAT activity was measured with the modified method of Nelson and Kiesow [19]. This assay involved a change in absorbance at 240 nm due to the CAT-

dependent decomposition of hydrogen peroxide. CAT activity was expressed as nmol CAT per milligram protein. SOD activity was determined based on the inhibition of the radical superoxide reaction with adrenalin as described by McCord and Fridovich [20]. In this method, SOD present in the sample competes with the detection system for the superoxide radical. The results were expressed as IU SOD per milligram protein.

2.6. Milk Quality: Centesimal Composition, Urea, and Somatic Cell Count of Milk

Analyses of chemical composition, a standard plate count of bacteria, and a somatic cell count (SCC) were performed by the Commercial Milk Quality Laboratory, Curitiba, PR, accredited to the Ministry of Agriculture, Livestock, and Supply by MAPA ordinance. The quantification of fat, protein, lactose, total solids, and the defatted dry extract was performed using the Mid-Infrared Spectrometry Method, according to ISO 9622—IDF Standard 141:2013. The total bacterial count was performed using the Flow Cytometry Method, according to ISO 21187—IDF Standard 196/2021, and the SCC by the Flow Cytometry Method, according to ISO 13366-2—IDF Standard 148-2/2006.

2.7. Fatty Acid (FA) Profile in Milk

The extraction was performed using the method described by Bligh and Dyer [21]. Samples (3 mL) were added to 50 mL polypropylene tubes, and 16 mL of methanol and 8 mL of chloroform were added for the homogenization and complete disintegration of the sample, followed by mechanical stirring for 60 min. Thereafter, 8 mL of chloroform and Na₂SO₄ 1.5% solution were added to promote a biphasic system. This mixture was shaken for 2 min and then centrifuged for 15 min at 2000 rpm. The lipids obtained from the chloroform phase were subjected to fatty acid analysis.

FA methylation was performed using the transesterification method proposed by Hartman and Lago [8,22]. The extracted lipids were added to 1 mL of 0.4 M KOH methanolic solution in a test tube and shaken in a vortex for 1 min. The samples were kept in a water bath for 10 min at boiling point. Subsequently, they were cooled to room temperature, and 3 mL of 1 M H₂SO₄ methanolic solution was added, shaken in a vortex, and maintained in a water bath for 10 min. After cooling, 2 mL hexane was added, and the mixture was centrifuged at 2000 rpm for 10 min. Lastly, hexane with fatty acid methyl esters (FAMES) was subjected to chromatographic analysis.

For FAME determination, a gas chromatograph (TRACE 1310) equipped with a flame ionization detector (Thermo Scientific) was used. One microliter of sample was injected into a split/splitless injector operated in a 1:10 split mode at 250 °C. Hydrogen was used as the carrier gas at a constant flow rate of 1.5 mL/min. FAME separation was performed using an RT 2560 (100 m × 0.25 mm × 0.20 µm of thickness film, Restek, Bellefonte, PA, USA) chromatography column. The initial oven temperature was programmed to be 100 °C for 5 min and then increased to 180 °C at 8 °C/min. Then, it was increased to 210 °C at 4 °C/min, and finally, until 240 °C, it was increased to 20 °C/min, and it was maintained for 20 min under isothermal conditions. The detector temperature was maintained at 250 °C. The FAME compounds were identified by comparing the experimental retention times to those of authentic standards (FAME Mix-37, Sigma Aldrich, St. Louis, MO, USA). The results were presented as a percentage of each FA identified in the lipid fraction, considering the chain size equivalent factor of FAMES for FID and the conversion factor of the ester to the respective acid, according to Visentainer and Franco [23].

2.8. Statistical Analysis

First, a descriptive analysis of the data was performed by applying the normality test (Shapiro–Wilk) and evaluating the residual error. The data without a normal distribution were transformed to logarithms and normalized for subsequent analyses. All data were

analyzed using the SAS ‘MIXED procedure’ (SAS Inst. Inc., Cary, NC, USA; version 9.4) with Satterthwaite’s approximation to determine the denominator degrees of freedom for the fixed-effects test. Mean milk production and feed efficiency variables were tested for a fixed effect of treatment using animals (treatment) as a random effect. The remaining data were analyzed as repeated measures and tested for fixed treatment effects using day and treatment $\times$ day, with cow (treatment) as a random effect. The d1 results were included as independent covariates. Additionally, for these variables, the d1 scores were removed from the dataset to generate the mean per treatment but were retained as covariates. The first-order autoregressive covariance structure was selected according to the lowest Akaike information criterion. Means were separated using the PDIF method (Student’s test), and all results were reported as LSMEANS followed by standard error (SEM). Significance was defined as $p \leq 0.05$, and a trend was indicated when $p > 0.05$ and ≤ 0.10 .

3. Results

3.1. Productive Performance

The performance results are presented in Table 2 and Figure 1. There was no effect of treatment on the average milk production per cow per day during the adaptation period (d1–14) and experimental period (d15–45) (Table 2). However, we observed a treatment $\times$ day interaction (Figure 1): the cows that consumed the phytobiotic additive produced a greater quantity of milk (d14, d17, d18, d30, d39 and d45). We observed 8.57% greater corrected milk production for fat percentage in the cows that consumed phytobiotics than in the control during the experimental period. The effect of the treatment on feed intake was 10.23% lower in cows that consumed the additive than in the control. The feed efficiency values were 15.38% higher in cows that consumed phytobiotics in both calculations using milk production per day and milk production corrected for 4% fat.

Table 2. Milk production (MP), fat-corrected milk (4% FCM).

Variables	Control	Phytobiotic	SEM	<i>p</i> : Treat ²
Milk production—MP. kg (mean)				
d −7 to 1 (pre-experiment)	22.2	22.6	0.22	0.95
d 1 to 14	22.6	22.8	0.20	0.94
d 15 to 45	25.2	26.0	0.19	0.15
Fat-corrected milk (4%FCM) ¹ . kg				
d −7 to 1	18.5	19.5	0.2	0.84
d 1 to 14	20.2	21.7	0.18	0.76
d 15 to 45	24.5 ^b	26.6 ^a	0.17	0.01
Feed intake—FI. kg (mean)				
d 1 to 14	16.5	16.2	0.14	0.95
d 15 to 45	17.6 ^a	15.8 ^b	0.12	0.01
Feed efficiency (kg DM/kg FI)				
d 15 to 45	1.43 ^b	1.65 ^a	0.04	0.01
Body score				
d1	3.25	3.08	0.08	0.62
d45	3.34	3.11	0.07	0.12

Note¹: Milk production corrected for 4% fat (4%FCM) was estimated by the equation proposed by the NRC (2001) [10]: $FCM = 0.4 \times (\text{kg of milk produced}) + 0.15 \times (\% \text{ fat}) \times (\text{kg of milk produced})$. Note²: The treatment effect when $p < 0.05$, with the difference between groups illustrated by different lowercase letters (a and b) in the same row.

3.2. Milk Quality

The results of centesimal composition and SCC in milk are presented in Table 3. There was an effect of treatment and day; thus, there was a treatment $\times$ day interaction for milk fat, with cows in the phytobiotic group having the highest milk fat compared to the control group. There was no effect of day, treatment, or treatment $\times$ day interaction on protein, lactose, total solids, urea, and SCC in milk.

Table 3. Centesimal composition of milk from cows that consumed phytobiotics, milk urea levels, and somatic cell count (SCC).

Variables	Control	Phytobiotic	SEM	<i>p</i> : Treat ¹	<i>p</i> : Day ²	<i>p</i> : Treat × Day ³
Fat (g/kg)	36.5 ^b	40.1 ^a	0.47	0.01	0.05	0.01
Protein (g/kg)	36.9	36.8	0.35	0.97	0.96	0.97
Lactose (g/kg)	46.3	45.8	0.24	0.88	0.95	0.93
Total solids (g/kg)	120	123	1.75	0.91	0.96	0.92
Urea (mg/dL)	18.3	19.9	0.64	0.82	0.89	0.83
SCC (×10 ³ mL)	61.9	56.3	2.42	0.64	0.58	0.72
Fat (g/kg) ^{2,3}						
d14	32.9 ^{bB}	36.9 ^{aB}	0.46			
d28	34.1 ^{bAB}	37.8 ^{aB}	0.48			
d45	42.4 ^{bA}	45.6 ^{aA}	0.46			

Note ¹: The treatment effect when $p < 0.05$, with the difference between groups illustrated by different lowercase letters (a and b) in the same row. Note ²: The day effect when $p < 0.05$, illustrated by uppercase letters (A, and B) in the same column for milk fat in both groups. Note ³: This table demonstrates the treatment versus day interaction for fat on days 14, 28, and 45 of the experiment, with lowercase letters (a and b) in the same row.

The results of the milk fatty acid profile are presented in Table 4. No effect of treatment was observed for specific fatty acids. Still, there was a tendency for a higher sum of unsaturated fatty acids ($p = 0.09$) and monounsaturated fatty acids ($p = 0.07$) in the milk of cows that consumed the phytogenic. However, there was a small difference for the sum of polyunsaturated fatty acids (control: 1.51 and phytogenic: 1.61%), but this was significant between the groups due to the consumption of the additive. Consequently, we verify that a higher UFA/SFA ratio was observed in the milk of cows that consumed the phytogenic compared to the control.

Table 4. Fatty acid profile in milk from cows that consumed phytobiotics as feed additive.

Fatty Acid	Control	Phytobiotic	SEM	<i>p</i> -Value ¹
C4:0 (Butyric)	0.20	0.19	0.016	0.95
C6:0 (Caproic)	0.09	0.01	0.033	0.24
C10:0 (Capric)	2.42	2.10	0.156	0.36
C11:0 (Undecanoic)	0.21	0.15	0.024	0.23
C12:0 (Lauric)	3.20	3.11	0.078	0.78
C13:0 (Tridecanoic)	0.13	0.12	0.005	0.96
C14:0 (Myristic)	12.0	12.5	0.158	0.92
C14:1 (Myristoleic)	0.53	0.53	0.032	0.94
C15:0 (Pentadecanoic)	1.11	1.24	0.044	0.56
C16:0 (Palmitic)	43.9	43.1	0.504	0.91
C16:1 (Palmitoleic)	1.17	1.06	0.043	0.44
C17:0 (Heptadecanoic)	0.66	0.67	0.009	0.98
C17:1 (cis-10-Heptadecenoic)	0.12	0.11	0.004	0.95
C18:0 (Stearic)	10.8	11.9	0.275	0.18
C18:1n9t (Elaidic)	1.50	1.71	0.058	0.13
C18:1n9c (Oleic)	14.4	15.0	0.369	0.31
C18:2n6t (Linolelaidic)	0.02	0.01	0.001	0.99
C18:2n6c (Linoleic)	1.25	1.33	0.027	0.19
C20:0 (Arachidic)	0.14	0.16	0.003	0.35
C20:1n9 (cis-11-Eicosenoic)	0.07	0.08	0.003	0.96
C18:3n3 (α-Linolenic)	0.10	0.12	0.006	0.55

Table 4. Cont.

Fatty Acid	Control	Phytobiotic	SEM	p-Value ¹
C21:0 (Henicosaenoic)	0.20	0.25	0.016	0.47
C20:2 (cis-11.14-Eicosadienoic)	0.02	0.01	0.002	0.96
C22:0 (Behenic)	0.06	0.07	0.002	0.95
C20:3n6 (cis-8.11.14-Eicosatrienoic)	0.07	0.07	0.002	0.99
C20:4n6 (Arachidonic)	0.04	0.04	0.002	0.98
C22:2 (cis-13.16-Docosadienoic)	0.02	0.01	0.003	0.96
C24:0 (Lignoceric)	0.05	0.04	0.005	0.94
C20:5n3 (cis-5.8.11.14.17- Eicosapentaenoic)	0.01	0.01	0.000	0.99
C24:1n9 (Nervonic)	0.01	0.01	0.001	0.99
SFA ²	75.3	74.7	0.652	0.24
UFA	19.3	20.1	0.125	0.09
MUFA	17.8	18.5	0.097	0.07
PUFA	1.51 ^b	1.61 ^a	0.030	0.03
UFA/SFA	0.25 ^b	0.27 ^a	0.011	0.05

Note ¹: Different letters in the same row illustrate the treatment effect when $p \leq 0.05$. Note ²: saturated fatty acids (SFA), unsaturated fatty acids (UFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA).

3.3. Hematologic and Biochemical Changes

The results for blood variables are presented in Table 5 and Figure 2. The effect of the day and treatment $\times$ day interaction was observed for total leukocyte and lymphocyte counts, both of which were lower in the blood of cows in the phytobiotic group. There was no effect of treatment or interaction on the other blood count variables (the number of granulocytes, monocytes, platelets, hemoglobin concentration, and hematocrit percentage), except for the number of erythrocytes, which was higher in cows that consumed the additive. Figure 2 illustrates the treatment $\times$ day interaction and the effect of the day on leukocyte and lymphocyte counts.

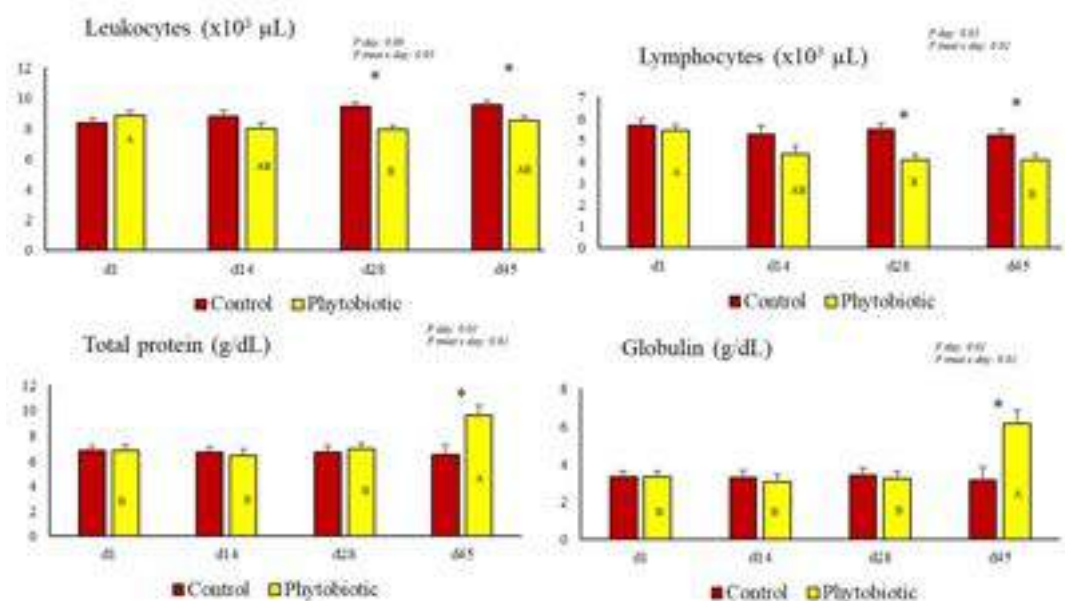


Figure 2. The effect of the treatment vs. day interaction (illustrated by asterisks above the bars) and day effect (shown by capital letters (A and B) inside the phytobiotic group bar) for total leukocyte, lymphocyte, total protein, and globulin biomarkers. The asterisk (*) illustrates the difference on each day, referring to the treatment $\times$ day interaction.

Table 5. Hemogram and serum biochemistry of cows fed phytobiotics.

Variables	Control	Phytobiotic	SEM	<i>p</i> : Treat ¹	<i>p</i> : Day ²	<i>p</i> : Treat × Day ²
Hematology						
Total leukocytes (×10 ³ µL)	9.22 ^a	8.02 ^b	0.35	0.05	0.08	0.05
Lymphocytes (×10 ³ µL)	5.33 ^a	4.18 ^b	0.23	0.05	0.05	0.02
Granulocytes (×10 ³ µL)	3.16	3.26	0.20	0.89	0.82	0.93
Monocytes (×10 ³ µL)	0.72	0.79	0.04	0.87	0.79	0.81
Erythrocytes (×10 ⁶ µL)	4.98 ^b	5.44 ^a	0.08	0.05	0.18	0.12
Hemoglobin (g/dL)	9.10	9.31	0.14	0.26	0.31	0.26
Hematocrit (%)	26.1	26.4	0.41	0.92	0.94	0.88
Platelets (×10 ³ µL)	370	339	20.9	0.55	0.63	0.61
Serum biochemistry						
Albumin (g/dL)	3.40	3.45	0.08	0.97	0.95	0.92
Total cholesterol (mg/dL)	140	139	1.21	0.91	0.89	0.89
Fructosamine (mg/dL)	325	330	2.05	0.85	0.81	0.87
GGT (U/L) ³	30.1	31.0	1.25	0.95	0.94	0.94
Glucose (mg/dL)	64.4	60.7	2.36	0.88	0.84	0.85
Total protein (g/dL)	6.67 ^b	7.77 ^a	0.11	0.05	0.01	0.01
AST (U/L) ³	88.7	94.6	3.32	0.56	0.26	0.39
ALT (U/L) ³	71.3	72.2	2.67	0.92	0.94	0.94
Triglycerides (mg/dL)	10.2	9.95	0.98	0.96	0.95	0.97
Urea (mg/dL)	42.4	45.8	1.54	0.66	0.51	0.45
Globulin (g/dL)	3.26 ^b	4.31 ^a	0.13	0.05	0.01	0.01

Note ¹: Treatment effect when $p < 0.05$, with difference between groups illustrated by different lowercase letters (a, b) in same line. Note ²: Day effect and treatment × day interaction when $p < 0.05$; results are shown in Figure 2. Note ³: GGT (gamma-glutamyl transferase), AST (aspartate aminotransferase) and ALT (alanine aminotransferase).

Total protein and globulin levels were higher in the serum of cows in the phytobiotic group compared to the control (Table 5), emphasizing the higher protein concentration on day 45 of the experiment (Figure 2). No effect of treatment or treatment × day interaction was observed for albumin, cholesterol, fructosamine, GGT, AST, ALT, triglycerides, glucose, or urea.

Protein profiles obtained by electrophoresis are shown in Table 6 and Figure 3. Higher levels of IgA, Ig heavy chain (Ig-hc), and transferrin were observed in the serum of cows fed the phytobiotic ($p < 0.05$). Ceruloplasmin and haptoglobin levels were lower in the serum of these cows than in that of the control ($p < 0.05$). A treatment × day interaction was observed mainly on day 45 for IgA, Ig-hc, haptoglobin, and transferrin (Figure 3).

We verified the effect of the treatment and day and the treatment × day interaction for cytokine levels (Table 6 and Figure 4). Lower levels of TNF, IL-1 and IL-6 and higher levels of IL-10 in the serum of cows that consumed the phytobiotic compared to the control were observed.

Oxidative status markers were presented in Table 6 and Figure 5. There was no treatment effect for ROS, but there was a day effect and treatment × day interaction for this variable, with lower ROS levels observed in the cows in the phytobiotic group compared to the control on day 28 of the experiment. There was a treatment, day, and interaction effect for TBARS levels, which was lower in cows that consumed the phytobiotic on days 14, 28, and 45. MPO activity only had a treatment effect, with higher enzymatic activity in the cows in the phytobiotic group compared to the control. CAT activity was higher in the blood of cows that consumed the phytogenic compared to the control. SOD activity was higher in the blood of cows that consumed additives on days 28 and 45 compared to the control.

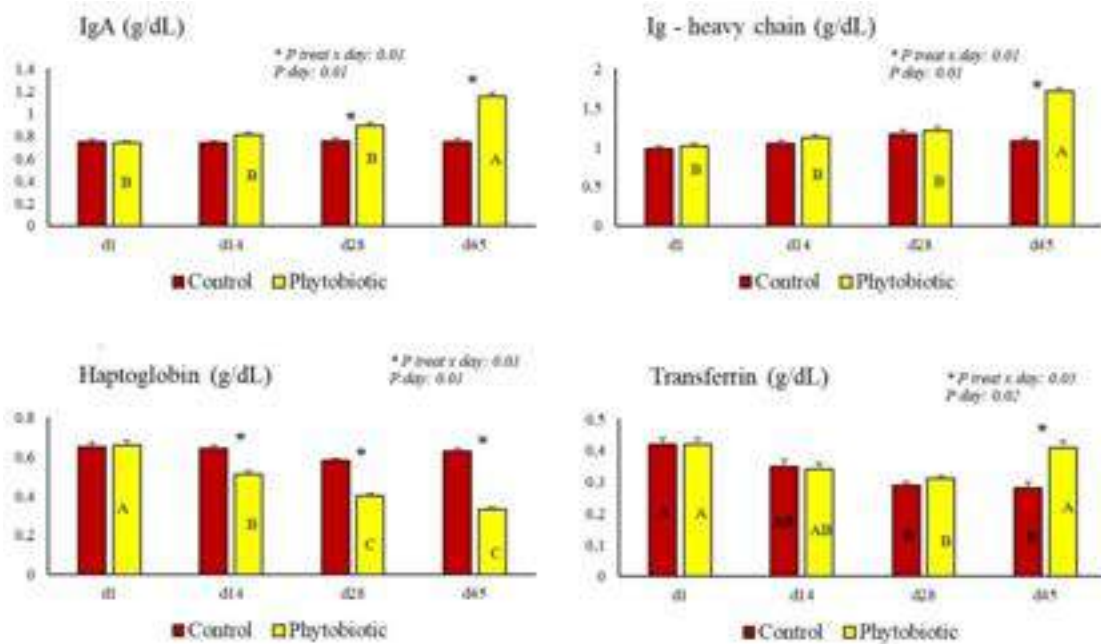


Figure 3. The effect of treatment vs. day interaction (illustrated by asterisks above the bars) and day effect (shown by capital letters (A, B, and C) inside the bar) for biomarkers IgA, Ig-hc, haptoglobin, and transferrin. The asterisk (*) illustrates the difference on each day, referring to the treatment $\times$ day interaction.

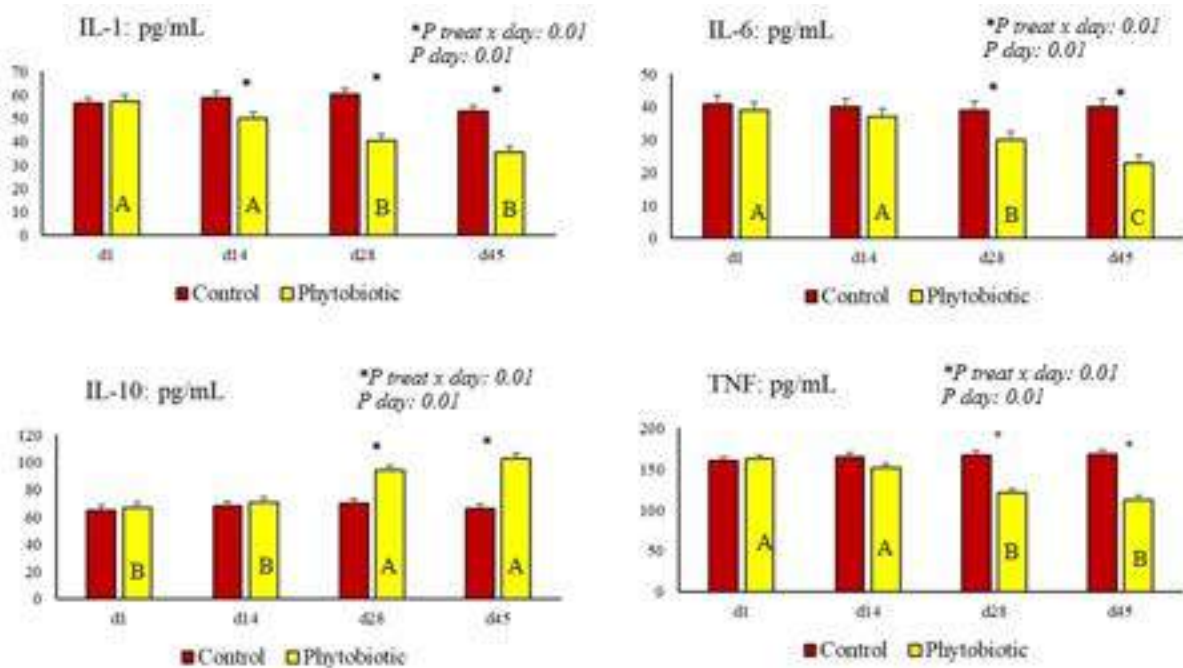


Figure 4. The effect of treatment vs. day interaction (illustrated by asterisks above the bars) and day effect (shown by capital letters (A, B and C) inside the bar) for the cytokine biomarkers (IL-1, IL-6, IL-10 and TNF). The asterisk (*) illustrates the difference on each day, referring to the treatment $\times$ day interaction.

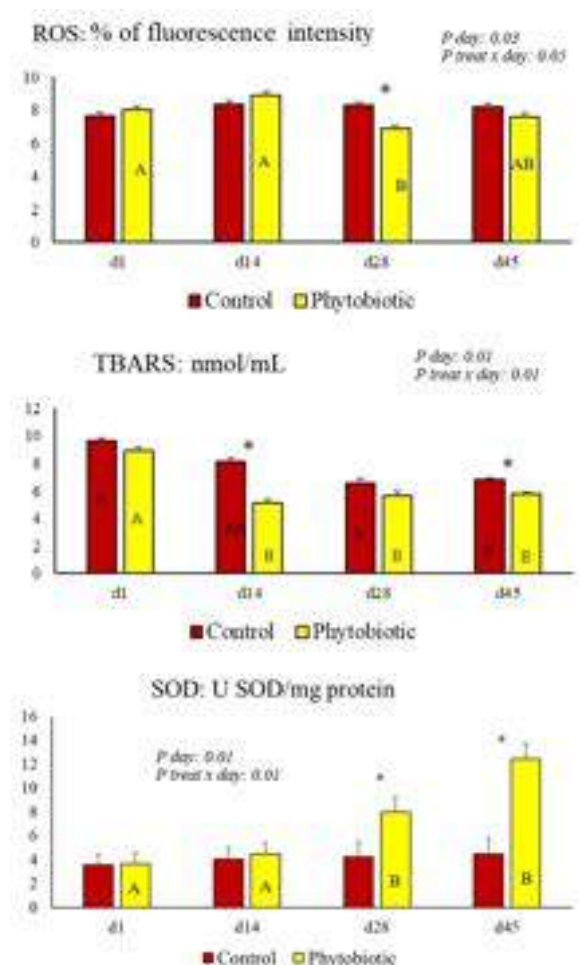


Figure 5. The treatment $\times$ day interaction (illustrated by asterisks above the bars) and day effect (shown by capital letters (A and B) inside the bar) for reactive oxygen species (ROS) and lipid peroxidation (TBARS) in serum and superoxide dismutase (SOD) in total blood from phytobiotic-fed cows. The asterisk (*) illustrates the difference on each day, referring to the treatment $\times$ day interaction.

Table 6. Protein profile in electrophoresis and markers of oxidative reactions of cows fed phytobiotics.

Variables	Control	Phytobiotic	SEM	<i>p</i> : Treat ¹	<i>p</i> : Day ²	<i>p</i> : Treat $\times$ Day ²
Proteinogram						
IgA (g/dL)	0.75 ^b	0.98 ^a	0.03	0.01	0.01	0.01
Heavy-chain Ig (g/dL)	1.12 ^b	1.46 ^a	0.05	0.01	0.01	0.01
Ceruloplasmin (g/dL)	0.65 ^a	0.52 ^b	0.02	0.05	0.22	0.26
Haptoglobin (g/dL)	0.61 ^a	0.42 ^b	0.02	0.01	0.01	0.01
Ferritin (g/dL)	0.40	0.37	0.01	0.65	0.74	0.68
Transferrin (g/dL)	0.32 ^b	0.36 ^a	0.01	0.05	0.02	0.05
Cytokines						
IL-1 β (pg/mL)	56.9 ^a	42.9 ^b	2.58	0.01	0.01	0.01
IL-6 (pg/mL)	40.1 ^a	29.5 ^b	2.27	0.04	0.01	0.01
IL-10 (pg/mL)	65.8 ^b	94.3 ^a	3.41	0.01	0.01	0.01
TNF (pg/mL)	164 ^a	135 ^b	5.02	0.03	0.01	0.01
Oxidative status						
ROS ³ (% of fluorescence intensity)	8.20 ^a	7.60 ^b	0.22	0.19	0.03	0.05
TBARS (nmol/mL)	6.83 ^a	5.77 ^b	0.13	0.02	0.01	0.01
MPO (μ M quinoneimin/30 min)	2.27	2.75	0.02	0.05	0.14	0.20
CAT (nmol CAT/mg of protein)	9.74	11.2	0.45	0.04	0.11	0.13
SOD (U SOD/mg of protein)	4.23	8.23	0.31	0.01	0.01	0.01

Note¹: The treatment effect when $p < 0.05$, with the difference between groups illustrated by different lowercase letters (a and b) in the same line. Note²: The day effect and treatment $\times$ day interaction when $p < 0.05$, with the results presented in Figures 3 and 4. Note³: reactive oxygen species (ROS), thiobarbituric acid reactive substances (TBARS), myeloperoxidase (MPO), catalase (CAT) and superoxide dismutase (SOD).

4. Discussion

In a practical and applied way, these studies showed that the intake of phytobiotic additives by Jersey cows influence productive performance corrected to fat, feed intake, feed efficiency, and fat percentage in milk. Some of these results corroborate those of another recently published study on the photoactivities of Jersey cows [24] and Lacaune sheep [25]; but it is important to emphasize that the studies used different formulations, so a comparison needs to be made with caution. The present study tested cinnamon and oregano EOs in free and microencapsulated forms, unlike the study by Vitt et al. [24], which used the same concentration of these EO only in microencapsulated form. Maxin et al. [26] reported that the fat content in cow's milk is altered by acetate and butyrate; that is, when they increase, there is a decrease in propionate, glucose, and fat content in milk, which has already been described in other studies with phytobiotics similar to the one tested here [8,9,24]. A lower feed intake may be related to the free EO in the additive, which generated a greater odor in the concentrate and total diet, and reduced intake. Despite this, milk production in these cows was equal between groups; consequently, because when we calculated the feed efficiency value, we found that it was significantly higher in the cows that consumed the phytogetic. Among the additive ingredients tested, we found that turmeric extract contains curcumin, already described as responsible for improving the digestibility of sheep fiber and thus increasing milk production [27], as well as improving the digestibility of feed and nutrients in dairy cows fed *Curcuma longa* extract in the diet [28]. However, we cannot rule out other nutritional mechanisms that are capable of altering milk composition and growth performance, such as how the use of essential oils (oregano and cinnamon) [5] and tannins [29] alters the acetate/propionate ratio and amount of short-chain fatty acids (SCFAs). We observed a day effect for milk fat, which increased throughout the experiment; however, this increase was higher in the phytobiotic group. The explanation for the day effect in both groups is related to the feeding of these cows before starting the experiment, i.e., the cows had access to pasture and were animals in the early phase of lactation (less than 30 days postpartum); this is a physiological and common moment in which the animal is in a negative energy balance and has an unstable metabolism. At the end of the experiment, the percentage of milk fat reached the reference value for the Jersey breed at peak production. The exact mechanism that led to the increase in fat in the animals that consumed the phytobiotic will be investigated in the future by our research group, evaluating ruminal fermentation, volatile fatty acids, and ruminal and intestinal microbiota.

The exact mechanism involved in this increase in milk fat is unknown. However, in the future, we will investigate the influence of this additive on lipid metabolism, which did not change serum cholesterol levels. The additive positively influenced the composition of fatty acids in milk, increasing the index of polyunsaturated fatty acids. The addition of curcumin to dairy sheep feed increases monounsaturated fatty acids [27] and the use of tannins in goats increases oleic acid [30]. According to the literature, tannins can inhibit the last step of ruminal biohydrogenation; therefore, this increases the content of unsaturated fatty acids in milk [31]. However, it is worth noting that the effect of the additive on milk quality was moderate, i.e., only affecting fat. We did not hypothesize that the consumption of the additive would alter protein and lactose levels in the milk; but we expected a reduction in SCC, as had already been described in another study with a phytogetic [24]. The blood results discussed below suggest an anti-inflammatory effect of the additive, which could have reduced the somatic cell count in the milk, but this did not occur, which may be related to other local factors in the mammary gland, which are not known.

Lower blood leukocyte counts due to reduced lymphocytes were observed in cows fed phytobiotics. This change suggests that the additive interferes with the modulation of

inflammatory processes [32,33], thus favoring an anti-inflammatory effect. Lower leukocyte counts have already been verified in the consumption of curcumin by dairy sheep [27] and dairy calves [34], as well as the ingestion of microencapsulated cinnamon and oregano oil in the diet of lambs [35]. Adding chestnut tannin to the diet of cows increased leukocyte and lymphocyte counts but reduced the neutrophil/lymphocyte ratio [36]. It is important to make it clear to the reader that the lower leukocyte/lymphocyte count could also indicate immunosuppression, but due to the promising productive results, as well as other blood biomarkers, we believe that this reduction in the count of this cell is an anti-inflammatory effect, confirmed by the lower concentration of pro-inflammatory cytokines (IL-1 β , IL-6, and TNF) and higher anti-inflammatory cytokine levels (IL-10).

A higher concentration of total proteins due to increased globulins was observed in this study. As the animals were apparently healthy, without any sign of dehydration, we interpreted the reduction in total protein as an immunological effect, confirmed by the protein profile determined by electrophoresis. Higher globulin levels have already been recorded in lactating goats fed a diet based on cinnamon, ginger, and garlic oils [37]. The same commercial product tested here did not alter total protein and globulin levels when used in the diet of feedlot beef cattle [8]. However, similar additives in a phytogenic blend increased globulin levels in growing steers [9] and lactating cows [24]. A leukogram showed a lower total lymphocyte count. However, the number of globulins was higher, which suggests that there was a reduction in T lymphocytes and possibly an increase in B lymphocytes or more significant activity of these cells, which resulted in a greater production of immunoglobulins, as observed in our study, where cows fed phytobiotics had a higher concentration of serum IgA, similar to that found in other studies by our research group [9,24,38,39]. However, this is the hypothesis of modulation for greater IgA; but we cannot rule out the possibility that the additive causes irritation in the intestinal mucosa, which could also stimulate the increase in this immunoglobulin. It is essential to highlight that the concentration of other heavy-chain immunoglobulins also increases, reinforcing that the ingestion of this additive stimulates a humoral response [40]. There is a hypothesis that immunoglobulins increase by the direct action of the additive's ingredients on humoral immune cells, and another possibility is that the components of the additive (mainly essential oil and tannin) sensitize the intestinal mucosa, which is an immune and defense response, and increase IgA levels.

The reduction in lymphocytes, combined with a lower concentration of positive acute-phase proteins (ceruloplasmin and haptoglobin) and an increase in harmful acute-phase protein (transferrin), helps to characterize an anti-inflammatory response that has been commonly described in ruminants fed with phytobiotics [24,39,41,42]. It is already known that the combination of microencapsulated oils of carvacrol, cinnamaldehyde, and thymol has anti-inflammatory effects [41,42]. Tung et al. [43] observed that *Cinnamomum osmophloeum* EO could strongly inhibit nitric oxide (NO) production in RAW 264.7 cells after exposure to lipopolysaccharide (LPS), highlighting the involvement of cinnamaldehyde in this activity. The ability of cinnamaldehyde to reduce inducible nitric oxide synthase (iNOS) mRNA synthesis in RAW 264.7 cells has been noted [44]. Curcumin reduces the activity of enzymes that mediate inflammation, such as cyclooxygenase-2 (COX-2), lipoxygenase (LOX), and iNOS, and reduces the levels of pro-inflammatory cytokines [45,46]. Wijesinghe et al. [47] suggested that plant tannins exert anti-inflammatory effects by inhibiting NO and prostaglandin-E2. In summary, the anti-inflammatory effect observed here was expected and may indirectly be responsible for the higher milk production of these cows because reducing the inflammatory response required less ATP consumption to maintain inflammation, and more energy was available for milk production.

Lower levels of TBARS and ROS combined with the greater activity of antioxidant enzymes CAT and SOD were observed in this study, similar to those described in other studies on phytobiotics in ruminants [8,9,24,39]. It is well known that curcumin has antioxidant effects in sheep [48,49], and cinnamon and oregano EOs decrease lipid peroxidation as they have compounds with a high capacity to absorb oxygen radicals [50] and tannins, which are plant metabolites that have antioxidant activity and can be used to improve the antioxidant status of animals [51]. According to the literature, curcumin has active groups capable of neutralizing free radicals and stimulating antioxidant enzymes such as SOD, glutathione peroxidase, and glutathione S-transferase [52,53]. Furthermore, a meta-analysis showed that curcumin, when consumed, reduces the concentration of malondialdehyde (MDA) in serum and has the potential to increase the total antioxidant potential, consequently removing reactive oxygen and nitrogen, chelating metals, and regulating numerous enzymes [54].

5. Conclusions

The inclusion of a phytobiotic additive based on a combination of oregano and cinnamon EO (free and microencapsulated) associated with turmeric and tannin extract in the diet of Jersey cows has positive effects under these experimental conditions, enhancing fat-corrected milk (4%FCM), and it is also capable of increasing fat in milk, generating a partial improvement in milk quality since milk protein, lactose and SCC are not altered. However, the addition of the phytogenic reduced the cows' feed intake but maintained production, leaving the calculated feed efficiency value of these cows higher. The intake of the additive by the cows had an anti-inflammatory effect, capable of reducing pro-inflammatory markers, such as acute-phase proteins, but stimulated the production of immunoglobulins. A reduction in lipid peroxidation and ROS levels indicates that the additive has an antioxidant effect with higher CAT and SOD activity and can reduce and minimize physiological oxidative stress in lactating cows.

Author Contributions: E.P.d.M., M.M.B. and A.S.d.S. contributed to the design and implementation of the research and the analysis of the results. M.D.B. helped in the elaboration of the project and its execution and financing. E.P.d.M., T.L.d.S., R.S.d.J., G.L.D., L.N., M.A.T. and A.S.d.S. participated in the execution of the experiment and collection of samples and data. G.B.d.S., D.M. and F.M.J. conducted the laboratory analysis. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The project was approved by the animal welfare ethics committee from the Universidade do Estado de Santa Catarina (approval number 3142281124).

Informed Consent Statement: Not applicable.

Data Availability Statement: The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author.

Acknowledgments: We thank the technical and scientific support of CAPES, CNPq, FAPESC, UDESC and Techpy.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Van Boeckel, T.P.; Pires, J.; Silvester, R.; Zhao, C.; Song, J.; Criscuolo, N.G.; Laxminarayan, R. Global trends in antimicrobial resistance in animals in low- and middle-income countries. *Science* **2019**, *365*, eaaw1944. [[CrossRef](#)]
2. Patra, A.K.; Saxena, J. Exploitation of dietary tannins to improve rumen metabolism and ruminant nutrition. *J. Sci. Food Agric.* **2010**, *91*, 24–37. [[CrossRef](#)] [[PubMed](#)]

3. Benchaar, C.; Calsamiglia, S.; Chaves, A.V.; Fraser, G.R.; Colombatto, D.; McAllister, T.A.; Beauchemin, K.A. A review of plant-derived essential oils in ruminant nutrition and production. *Anim. Feed Sci. Technol.* **2008**, *145*, 209–228. [[CrossRef](#)]
4. Khan, H.; Ullah, H.; Nabavi, S.M. Mechanistic insights of hepatoprotective effects of curcumin: Therapeutic updates and future prospects. *Food Chem. Toxicol.* **2018**, *124*, 182–191. [[CrossRef](#)]
5. Calsamiglia, S.; Busquet, M.; Cardozo, P.; Castillejos, L.; Ferret, A. Invited review: Essential oils as modifiers of rumen microbial fermentation. *J. Dairy Sci.* **2007**, *90*, 2580–2595. [[CrossRef](#)]
6. Yarru, L.P.; Settivari, R.S.; Gowda, N.K.S.; Antoniou, E.; Ledoux, D.R.; Rottinghaus, G.E. Effects of turmeric (*Curcuma longa*) on the expression of hepatic genes associated with biotransformation, antioxidant, and immune systems in broiler chicks fed aflatoxin. *Poult. Sci.* **2009**, *88*, 2620–2627. [[CrossRef](#)]
7. Vieira, L.V.; Schmidt, A.P.; Barbosa, A.A.; de Oliveira Feijó, J.; Brauner, C.C.; Rabassa, V.R.; Corrêa, M.N.; Schmitt, E.; Del Pino, F.A.B. Utilização de taninos como aditivo nutricional na dieta de ruminantes. *Arq. De Ciênc. Vet. E Zool. Da UNIPAR* **2020**, *23*, e2306. [[CrossRef](#)]
8. Lago, R.V.P.; Wolschick, G.J.; Signor, M.H.; Giral di, G.C.; Mollosse, V.L.; Deolindo, G.L.; Cecere, B.G.O.; Brunetto, A.L.R.; Cucco, D.C.; Bendeti, P.D.B.; et al. A mixture of free and microencapsulated essential oils combined with turmeric and tannin in the diet of cattle in the growing and finishing phase: A new tool to enhance productivity. *Anim. Feed. Sci. Technol.* **2024**, *315*, 116033. [[CrossRef](#)]
9. Brunetto, A.L.; Giacomelli, C.M.; Favero, J.F.; Bissacotti, B.F.; Copeti, P.M.; Morsch, V.M.; Da Silva, A.S. Phytogetic blend in the diet of growing Holstein steers: Effects on performance, digestibility, rumen volatile fatty acid profile, and immune and antioxidant responses. *Anim. Feed. Sci. Technol.* **2023**, *297*, 115595. [[CrossRef](#)]
10. National Research Council (NRC). *Nutrient Requirements of Dairy Cattle*; National Academy of Sciences: Washington, DC, USA, 2001.
11. Silva, D.J.; Queiroz, A.C. *Análises de Alimentos (Métodos Químicos e Biológicos)*, 3rd ed.; UFV: Abbotsford, Canada, 2002; Volume 3, p. 235.
12. Van Soest, P.J.; Wine, R.H. Determination of lignin and cellulose in acid detergent fiber with permanganate. *J. Assoc. Agric. Chem.* **1968**, *51*, 780–785. [[CrossRef](#)]
13. Fagliari, J.J.; Santana, A.E.; Lucas, F.A.; Campos, E.; Curi, P.R. Constituintes Sangüíneos De bovinos recém-nascidos das raças nelore (*Bos indicus*) e holandesa (*Bos taurus*) e de bubalinos (*Bubalus bubalis*) da raça Murrah. *Arq. Bras. Med. Vet. Zootec.* **1998**, *50*, 253–262.
14. Tomasi, T.; Volpato, A.; Pereira, W.A.B.; Debastiani, L.H.; Bottari, N.B.; Morsch, V.M.; Schetinger, M.R.C.; Leal, M.L.R.; Machado, G.; Da Silva, A.S. Metaphylactic effect of minerals on the immune response, biochemical variables and antioxidant status of newborn calves. *J. Anim. Physiol. Anim. Nutr.* **2018**, *102*, 819–824. [[CrossRef](#)]
15. Ali, S.F.; LeBel, C.P.; Bondy, S.C. Reactive oxygen species formation as a biomarker of methylmercury and trimethyltin neurotoxicity. *Neurotoxicology* **1992**, *13*, 637–648.
16. Jentzsch, A.M.; Bachmann, H.; Furst, P.; Biesalski, H.K. Improved analysis of malondialdehyde in human body fluids. *Free. Radic. Biol. Med.* **1996**, *20*, 251–256. [[CrossRef](#)] [[PubMed](#)]
17. Suzuki, K.; Ota, H.; Sasagawa, S.; Sakatani, T.; Fujikura, T. Assay method for myeloperoxidase in human polymorphonuclear leukocytes. *Anal. Biochem.* **1983**, *132*, 345–352. [[CrossRef](#)]
18. Bradford, M.M. A rapid and sensitive method for the quantification of microgram quantities of protein utilizing the principle of protein-dye binding. *Anal. Biochem.* **1976**, *72*, 218–254. [[CrossRef](#)]
19. Nelson, D.P.; Kiesow, L.A. Enthalpy of decomposition of hydrogen peroxide by catalase at 25 °C (with molar extinction coefficients of H₂O₂ solutions in the UV). *Anal. Biochem.* **1972**, *49*, 474–478. [[CrossRef](#)] [[PubMed](#)]
20. McCord, J.M.; Fridovich, I. Superoxide dismutase: An enzymatic function for erythrocuprein (hemocuprein). *J. Biol. Chem.* **1969**, *244*, 6049–6055. [[CrossRef](#)]
21. Bligh, E.G.; Dyer, W.J. A rapid method of total lipid extraction and purification. *Can. J. Biochem. Physiol.* **1959**, *37*, 911–917. [[CrossRef](#)]
22. Hartman, L.; Lago, R.C. Rapid preparation of fatty acid methyl esters from lipids. *Lab. Pract.* **1973**, *22*, 475–477.
23. Visentainer, J.V.; Franco, M.R.B. *Fatty Acids in Oils and Fats: Identification and Quantification*; Varela: São Paulo, Brazil, 2006.
24. Vitt, M.G.; Signor, M.H.; Corrêa, N.G.; Breancini, M.; Wolschick, G.J.; Klein, B.; Silva, L.E.L.; Wagner, R.; Jung, C.T.K.; Kozloski, G.V.; et al. Combination of phytoactives in the diet of lactating Jersey cows: Effects on productive efficiency, milk composition and quality, ruminal environment, and animal health. *Animals* **2024**, *14*, 2518. [[CrossRef](#)] [[PubMed](#)]
25. Cunha, M.G.; Alba, D.F.; Leal, K.W.; Marcon, H.; Milarch, C.F.; Baldissera, M.D.; Kavalek, R.L.; Kempka, A.P.; Vedovatto, M.; Silva, A.S. Microencapsulated herbal components in the diet of Lacaune ewes: Impacts on physiology and milk production and quality. *An. Acad. Bras. Cienc.* **2023**, *95*, e20201805. [[CrossRef](#)] [[PubMed](#)]
26. Maxin, G.; Rulquin, H.; Glasser, F. Response of milk fat concentration and yield to nutrient supply in dairy cows. *Animal* **2011**, *5*, 1299–1310. [[CrossRef](#)]

27. Jaguezski, A.M.; Perin, G.; Bottari, N.B.; Wagner, R.; Fagundes, M.B.; Schetinger, M.R.C.; Morsch, V.M.; Stein, C.S.; Moresco, R.N.; Barreta, D.A.; et al. Addition of curcumin to the diet of dairy sheep improves health, performance and milk quality. *Anim. Feed. Sci. Technol.* **2018**, *246*, 144–157. [\[CrossRef\]](#)
28. Hashemzadeh-Cigari, F.; Khorvash, M.; Ghorbani, G.R.; Kadivar, M.; Riasi, A.; Zebeli, Q. Effect of supplementation with a phytobiotics-rich herbal mixture on performance, udder health, and metabolic status of Holstein cows with various levels of milk somatic cell counts. *J. Dairy Sci.* **2014**, *97*, 7487–7497. [\[CrossRef\]](#) [\[PubMed\]](#)
29. Wang, Z.; Zhao, Y.; Lan, X.; He, J.; Wan, F.; Shen, W.; Tang, S.; Zhou, C.; Tan, Z.; Yang, Y. Tannic acid supplementation in the diet of Holstein bulls: Impacts on production performance, physiological and immunological characteristics, and ruminal microbiota. *Front. Nutr.* **2022**, *9*, 1066074. [\[CrossRef\]](#)
30. Abo-Donia, F.M.; Yang, L.Y.; Hristov, A.N.; Wang, M.; Tang, S.X.; Zhou, C.S.; Han, X.; Kang, J.; Tan, Z.; He, Z. Effects of tannins on the fatty acid profiles of rumen fluids and milk from lactating goats fed a total mixed ration containing rapeseed oil. *Livest. Sci.* **2017**, *204*, 16–24. [\[CrossRef\]](#)
31. Vasta, V.; Makkar, H.P.S.; Mele, M.; Priolo, A. Ruminal biohydrogenation as affected by tannins in vitro. *Br. J. Nutr.* **2009**, *102*, 82–92. [\[CrossRef\]](#)
32. Bechara, G.H.; Szabó, M.P.J. Processo Inflamatório. Componente e Eventos Celulares, UNESP. 2006. Available online: https://www.fcav.unesp.br/Home/departamentos/patologia/GERVASIOHENRIQUEBECHARA/INFLAM_2006.pdf (accessed on 29 December 2024).
33. Hatcher, H.; Planalp, R.; Cho, J.; Torti, F.M.; Torti, S.V. Curcumin: From ancient medicine to current clinical trials. *Cell. Mol. Life Sci.* **2008**, *65*, 1631–1652. [\[CrossRef\]](#)
34. Glombowsky, P.; Volpato, A.; Campigotto, G.; Soldá, N.M.; da S dos-Santo, D.; Bottari, N.B.; Schetinger, M.R.C.; Morsch, V.M.; Rigon, F.; Schogor, A.L.B.; et al. A adição dietética de curcumina favorece o ganho de peso e possui ação antioxidante, antiinflamatória e anticoccidiana em bezerros leiteiros. *Rev. Colomb. Ciênc. Pecu.* **2020**, *33*, 16–31. [\[CrossRef\]](#)
35. Favaretto, J.A.; Alba, D.F.; Marchiori, M.S.; Marcon, H.J.; Souza, C.F.; Baldissera, M.D.; Bianchi, A.E.; Zanluchi, M.; Klein, B.; Wagner, R.; et al. Supplementation with a blend based on micro-encapsulated carvacrol, thymol, and cinnamaldehyde in lambs feed inhibits immune cells and improves growth performance. *Livest. Sci.* **2020**, *240*, 104144. [\[CrossRef\]](#)
36. Prodanović, R.; Nedić, S.; Vujanac, I.; Bojkovski, J.; Nedić, S.; Jovanović, L.; Kirovski, D.; Borozan, S. Dietary supplementation of chestnut tannins in prepartum dairy cows improves antioxidant defense mechanisms interacting with thyroid status. *Metabolites* **2023**, *13*, 334. [\[CrossRef\]](#) [\[PubMed\]](#)
37. Kholif, A.E.; Hassan, A.A.; El Ashry, G.M.; Bakr, M.H.; El-Zaiat, H.M.; Olafadehan, O.A.; Matloup, O.H.; Sallam, S.M.A. Phytogenic feed additives mixture enhances the lactational performance, feed utilization and ruminal fermentation of Friesian cows. *Anim. Biotechnol.* **2020**, *32*, 708–718. [\[CrossRef\]](#) [\[PubMed\]](#)
38. Nora, L.; Marcon, C.; Deolindo, G.L.; Signor, M.H.; Muniz, A.L.; Bajay, M.M.; Copetti, P.M.; Bissacotti, B.F.; Morsch, V.M.; da Silva, A.S. The Effects of a Blend of Essential Oils in the Milk of Suckling Calves on Performance, Immune and Antioxidant Systems, and Intestinal Microbiota. *Animals* **2024**, *14*, 3555. [\[CrossRef\]](#)
39. Leal, K.W.; Leal, M.L.R.; Breancini, M.; Signor, M.H.; Vitt, M.G.; Silva, L.E.L.; Wagner, R.; Jung, C.T.K.; Kozloski, G.V.; de Araujo, R.C.; et al. Essential oils and capsaicin in the diet of Jersey cows at early lactation and their positive impact on anti-inflammatory, antioxidant and immunological responses. *Trop. Anim. Health Prod.* **2024**, *56*, 247. [\[CrossRef\]](#)
40. Tothova, C.; Nagy, O.; Kovac, G. Acute phase proteins and their use in the diagnosis of diseases in ruminants: A review. *Vet. Med.* **2014**, *59*, 163–180. [\[CrossRef\]](#)
41. Fachini-Queiroz, F.C.; Kummer, R.; Estevão-Silva, C.F.; Carvalho, M.D.D.B.; Cunha, J.M.; Grespan, R.; Bersani-Amado, C.A.; Cuman, R.K.N. Effects of thymol and carvacrol, constituents of *Thymus vulgaris* L. essential oil, on the inflammatory response. *Evid.-Based Complement. Altern. Med.* **2012**, *2012*, 657026. [\[CrossRef\]](#)
42. Gholijani, N.; Gharagozloo, M.; Farjadian, S.; Amirghofran, Z. Modulatory effects of thymol and carvacrol on inflammatory transcription factors in lipopolysaccharide-treated macrophages. *J. Immunotoxicol.* **2016**, *13*, 157–164. [\[CrossRef\]](#)
43. Tung, Y.-T.; Chua, M.-T.; Wang, S.-Y.; Chang, S.-T. Anti-inflammation activities of essential oil and its constituents from indigenous cinnamon (*Cinnamomum osmophloeum*) twigs. *Bioresour. Technol.* **2008**, *99*, 850–856. [\[CrossRef\]](#)
44. Kim, B.H.; Lee, Y.G.; Lee, J.; Lee, J.Y.; Cho, J.Y. Regulatory effect of cinnamaldehyde on monocyte/macrophage-mediated inflammatory responses. *Mediat. Inflamm.* **2010**, *2010*, 529359. [\[CrossRef\]](#)
45. Menon, V.P.; Sudheer, A.R. Antioxidant and anti-inflammatory properties of curcumin. *Adv. Exp. Med. Biol.* **2007**, *595*, 105–125. [\[CrossRef\]](#)
46. Peng, Y.; Ao, M.; Dong, B.; Jiang, Y.; Yu, L.; Chen, Z.; Hu, C.; Xu, R. Anti-inflammatory effects of curcumin in the inflammatory diseases: Status, limitations and countermeasures. *Drug Des. Dev. Ther.* **2021**, *15*, 4503–4525. [\[CrossRef\]](#) [\[PubMed\]](#)
47. Wijesinghe, W.; Ahn, G.; Lee, W.W.; Kang, M.C.; Kim, E.A.; Jeon, Y.J. Anti-inflammatory activity of phlorotannin-rich fermented Ecklonia cava processing by-product extract in lipopolysaccharide-stimulated RAW 264.7 macrophages. *J. Appl. Phycol.* **2013**, *25*, 1207–1213. [\[CrossRef\]](#)

48. Molosse, V.L.; Souza, C.F.; Baldissera, M.D.; Glombowsky, P.; Campigotto, G.; Cazaratto, C.J.; Stefani, L.M.; Silva, A.S.D. Diet supplemented with curcumin for nursing lambs improves animal growth, energetic metabolism, and performance of the antioxidant and immune systems. *Small Rumin. Res.* **2019**, *170*, 74–81. [[CrossRef](#)]
49. Marcon, H.; Souza, C.F.; Baldissera, M.D.; Alba, D.F.; Favaretto, J.A.; Santos, D.S.; Da Silva, A.S. Effect of curcumin dietary supplementation on growth performance, physiology, carcass characteristics and meat quality in lambs. *Ann. Anim. Sci.* **2021**, *21*, 623–638. [[CrossRef](#)]
50. Bentayeb, K.; Vera, P.; Rubio, C.; Nerin, C. Adaptation of the ORAC assay to the common laboratory equipment and subsequent application to antioxidant plastic films. *Anal. Bioanal. Chem.* **2009**, *394*, 903–910. [[CrossRef](#)]
51. Soldado, D.; Bessa, R.J.B.; Jerónimo, E. Condensed Tannins as Antioxidants in Ruminants-Effectiveness and Action Mechanisms to Improve Animal Antioxidant Status and Oxidative Stability of Products. *Animals* **2021**, *11*, 3243. [[CrossRef](#)]
52. Madrigal-Santillan, E.; Madrigal-Bujaidar, E.; Alvarez-Gonzalez, I.; Sumaya-Martínez, M.T.; Gutiérrez-Salinas, J.; Bautista, M.; Morales-Gonzalez, A.; García-Luna, Y.; Gonzalez-Rubio, M.; Aguilar-Faisal, J.L.; et al. Review of natural products with hepatoprotective effects. *World J. Gastroenterol.* **2014**, *20*, 14787. [[CrossRef](#)]
53. Wellington, K.; Jarvis, B. Silymarin: A Review of its Clinical Properties in the Management of Hepatic Disorders. *BioDrugs* **2001**, *15*, 465–489. [[CrossRef](#)]
54. Jakubczyk, K.; Drużga, A.; Katarzyna, J.; Skonieczna-Żydecka, K. Antioxidant potential of curcumin—A meta-analysis of randomized clinical trials. *Antioxidants* **2020**, *9*, 1092. [[CrossRef](#)]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.



Francisco Roberto da Silva Machado Junior

Endereço para acessar este CV: <https://lattes.cnpq.br/6465472124843804>

Última atualização do currículo em 23/12/2025

Graduação em Engenharia de Alimentos pela Universidade Federal do Rio Grande (2007), mestrado (2010) e doutorado (2014) em Engenharia e Ciência de Alimentos pela mesma universidade, tendo desenvolvido uma parte da tese na Universidade Federal de Santa Catarina. Experiência na área da docência em disciplinas que abrangem diferentes áreas da engenharia, atuando também na área de pesquisa, com ênfase em engenharia e bioprocessos, bem como coordenação e execução de análises bromatológicas e físico-químicas em alimentos, principalmente nos seguintes temas: valorização de resíduos, cultivos submersos para obtenção de bioprodutos, ruptura e extração celular, encapsulamento e tecnologia supercrítica, composição química e determinação de perfil de ácidos graxos. **(Texto informado pelo autor)**

Identificação

Nome	Francisco Roberto da Silva Machado Junior
Nascimento	17/02/1980 - Rio Grande/RS - Brasil
Lattes ID	 6465472124843804
Orcid ID	 https://orcid.org/0000-0002-0960-2927
Nome em citações bibliográficas	MACHADO JUNIOR, F. R. S.; MACHADO JR, FRANCISCO R.S.; MACHADO, FRANCISCO R.S.; MACHADO JUNIOR, FRANCISCO ROBERTO DA SILVA; JUNIOR, FRANCISCO R. S. MACHADO; JUNIOR, FRANCISCO R.S. MACHADO; MACHADO, FRANCISCO; MACHADO JUNIOR, FRANCISCO

Endereço

Endereço residencial	Rua Lauro Muller - E - 454, Ap. 301 Santa Maria - Chapecó 89812214, SC - Brasil Telefone: 49 99647184
Endereço eletrônico	E-mail para contato : franciscojr_ea@yahoo.com.br E-mail alternativo : franciscojr.ea@gmail.com

Prêmios e títulos

- 2009** Estudante de Pós-Graduação Destaque durante o XI Encontro de Pós-Graduação dentro da VIII Mostra de Produção Universitária, Universidade Federal do Rio Grande

Formação acadêmica/titulação

- 2010 - 2014** Doutorado em Engenharia e Ciência de Alimentos.
Universidade Federal do Rio Grande, FURG, Rio Grande, Brasil
com **período sanduíche** em Universidade Federal de Santa Catarina (Orientador: José Vladimir de Oliveira)
Título: RUPTURA CELULAR, EXTRAÇÃO E ENCAPSULAMENTO DE ASTAXANTINA DE HAEMATOCOCCUS PLUVIALIS (VOLVOCALES, CHLOROPHYTA), Ano de obtenção: 2014
Orientador: Carlos André Veiga Burkert 
Co-orientador: Janaila Fernandes de Medeiros Burkert
Bolsista do(a): Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, CAPES, Brasil.
Palavras-chave: astaxantina, biomassa, carotenoide, lise enzimática, nanoencapsulamento, Haematococcus pluvialis.
Grande área: Ciências Agrárias / Área: Ciência e Tecnologia de Alimentos
Grande área: Ciências Agrárias / Área: Ciência e Tecnologia de Alimentos
- 2008 - 2010** Mestrado em Engenharia e Ciência de Alimentos.
Universidade Federal do Rio Grande, FURG, Rio Grande, Brasil
Título: CONVERSÃO POR VIA BIOTECNOLÓGICA DE GLICERINA RESIDUAL EM BIOMASSA DE LEVEDURAS COMO FONTE DE PROTEÍNAS E LIPÍDIOS, Ano de obtenção: 2012
Orientador: Carlos André Veiga Burkert
Bolsista do(a): Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, CAPES, Brasil.
Palavras-chave: Biodiesel; Biomassa; Glicerina; Yarrowia lipolytica.
Grande área: Ciências Agrárias / Área: Ciência e Tecnologia de Alimentos
Grande área: Ciências Agrárias / Área: Ciência e Tecnologia de Alimentos / Subárea: Engenharia de Alimentos
- 2000 - 2007** Graduação em Engenharia de Alimentos.
Universidade Federal do Rio Grande, FURG, Rio Grande, Brasil
Título: Secagem de Maça Fuji (Mallus pericae) em Camada Delgada para Produção de "Chips"
Orientador: Luiz Antônio de Almeida Pinto
- 1995 - 1998** Ensino Profissional de nível técnico em Contabilidade.
Escola Técnica Estadual Getúlio Vargas, E. T. E. G. V., Brasil

Formação complementar

- 2022 - 2022** Curso de curta duração em Introdução à Administração. (Carga horária: 30h).
UNOVA CURSOS, UNOVA, Brasil
- 2019 - 2019** Curso de curta duração em Metodologias Ativas e sua efetiva aplicabilidade nos espaços de aprendizagem. (Carga horária: 4h).
Uceff Faculdades - Chapecó, UCEFF, Brasil

- 2019 - 2019** Curso de curta duração em Rei da Derivada, Summaê e Trezentos: Aprendizagem ativa e colaborativa, par. (Carga horária: 2h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2019 - 2019** Curso de curta duração em Aprendizagem por Pares. (Carga horária: 3h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2019 - 2019** Curso de curta duração em Estratégias de ensino- aprendizagem e a saúde Docente. (Carga horária: 4h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2018 - 2018** Curso de curta duração em Educação Superior: Desafios e Possibilidades. (Carga horária: 2h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2018 - 2018** Curso de curta duração em Gerando resultados. (Carga horária: 4h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2018 - 2018** Curso de curta duração em Dinâmicas Didáticas: Cálculos e as Metodologias Ativas. (Carga horária: 3h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2017 - 2017** Curso de curta duração em Práticas Pedagógicas-Estratégias de Ensino. (Carga horária: 3h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2016 - 2016** Curso de curta duração em Neurociência e Docência no Ensino Superior. (Carga horária: 3h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2016 - 2016** Curso de curta duração em Orientação no processo ensino aprendizagem de alunos com deficiência. (Carga horária: 8h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2016 - 2016** Curso de curta duração em Práticas Pedagógicas para a Educação Superior- ENADE. (Carga horária: 3h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2016 - 2016** Curso de curta duração em Docência e Cultura como Meio de Aprendizagem. (Carga horária: 3h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2016 - 2016** Curso de curta duração em Professor: Voz e comunicação a seu favor. (Carga horária: 4h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2016 - 2016** Curso de curta duração em A Plataforma MOODLE como ferramenta de interação e aprendizagem. (Carga horária: 3h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2015 - 2015** Curso de curta duração em Metodologias Ativas de Ensino e Aprendizagem. (Carga horária: 4h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2015 - 2015** Curso de curta duração em Curso Programa de Capacitação dos Docentes-Orientação para Estágios e TCC's. (Carga horária: 4h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2015 - 2015** Curso de curta duração em Perspectivas e Desafios da Educação Superior Brasileira para o século XXI. (Carga horária: 4h).
Ueff Faculdades - Chapecó, UCEFF, Brasil
- 2014 - 2014** Curso de curta duração em Nanosafety: The safe production and handling of na. (Carga horária: 8h).
Associação Brasileira de Engenharia Química, ABEQ, Sao Paulo, Brasil
- 2012 - 2012** Curso de curta duração em Planejamento de Experimentos com o Statistica. (Carga horária: 6h).
Associação Brasileira de Engenharia Química, ABEQ, Sao Paulo, Brasil
- 2011 - 2011** Extensão universitária em Redação Científica - Método Lógico.. (Carga horária: 16h).
Universidade Federal do Rio Grande, FURG, Rio Grande, Brasil
- 2007 - 2007** Extensão universitária em Tecnologia de Vinhos. (Carga horária: 16h).
Universidade Estadual de Campinas, UNICAMP, Campinas, Brasil
- 2005 - 2005** Extensão universitária em Tecnologia de Cereais. (Carga horária: 4h).
Universidade Federal do Rio Grande, FURG, Rio Grande, Brasil
- 2005 - 2005** Extensão universitária em Bioquímica e Qualidade da Carne. (Carga horária: 8h).
Universidade Federal do Rio Grande, FURG, Rio Grande, Brasil
- 2005 - 2005** Extensão universitária em Tecnologia de Carnes. (Carga horária: 4h).
Universidade Federal do Rio Grande, FURG, Rio Grande, Brasil
- 2004 - 2004** Extensão universitária em Alimentos Congelados. (Carga horária: 16h).
Universidade Estadual de Campinas, UNICAMP, Campinas, Brasil

Atuação profissional

Faculdades de Itapiranga - FAI

- 2015 - 2015** Vínculo: Celetista , Enquadramento funcional: Professor Titular, Regime: Faculdades de Itapiranga Parcial
- 2016 - 2017** Vínculo: Celetista , Enquadramento funcional: Professor Titular, Regime: Faculdades de Itapiranga Parcial
- 2016 - 2017** Vínculo: Celetista , Enquadramento funcional: Professor Titular, Regime: Faculdades de Itapiranga Parcial

Atividades

- 02/2015 - 07/2015** Graduação, Engenharia Civil
Disciplinas ministradas:
Química Geral e Tecnológica
- 07/2016 - 02/2017** Graduação, Tecnologia em Alimentos
Disciplinas ministradas:
Sistema Industrial Agroalimentar
- 07/2016 - 02/2017** Graduação, Engenharia Civil
Disciplinas ministradas:
Química Geral e Tecnológica
- 02/2016 - 07/2016** Graduação, Tecnologia em Alimentos
Disciplinas ministradas:
- Orientação Acadêmica
- 02/2017 - 07/2017** Graduação, Engenharia Civil
Disciplinas ministradas:
Projeto Integrador II - Metodologia da Pesquisa

Universidade Federal da Fronteira Sul - UFFS

- 2023 - 2024** Vínculo: Professor Visitante , Enquadramento funcional: Professor contratado , Carga horária: 40, Regime: Universidade Federal da Fronteira SulDedicação exclusiva

Atividades**08/2023 - 07/2024** Graduação, Engenharia Ambiental e Sanitária*Disciplinas ministradas:*
*Energia Solar e Eólica***08/2023 - 07/2024** Graduação, Matemática*Disciplinas ministradas:*
*Matemática B - PIN***03/2024 - 07/2024** Graduação, Administração*Disciplinas ministradas:*
*Matemática B***03/2024 - 07/2024** Graduação, Geografia*Disciplinas ministradas:*
*Matemática B***Universidade do Estado de Santa Catarina - UDESC**

2024 - 2025 Vínculo: Bolsista , Enquadramento funcional: Técnico de ensino superior , Carga horária: 30, Regime: Universidade do Estado de Santa Catarina Parcial
 Outras informações:
 Atribuições de executar as análises do Laboratório de Nutrição Animal, coordenar e executar análises de composição química de alimentos, operar a cromatografia gasosa e tratar os dados de perfil de ácidos graxos em carne, ovo, leite e outros fluidos. Operar o NIRs e absorção atômica para análises específicas de alimentos e outras amostras. Responsável pelas análises de laboratório com foco em alimentos (proteína bruta, extrato etéreo, matéria mineral, FDN, FDA, fibra bruta, entre outros), análises de subprodutos da produção da carne (composição química e perfil de ácidos graxos).Atuação no projeto COMBINAÇÕES DE ADITIVOS ALIMENTARES NATURAIS COM AÇÃO ANTIMICROBIANA EM SUBSTITUIÇÃO A ANTIBIÓTICO CONVENCIONAIS NA AVICULTURA DE CORTE: IMPACTOS SOBRE EFICIÊNCIA PRODUTIVA E COMPOSIÇÃO E QUALIDADE DE CARNE Multilaboratórios (Anatomia e Fisiologia Animal, Morfofisiologia Vegetal, Solos e Sustentabilidade, Nutrição Animal e Microscopia e Parasitologia, Microbiologia e Biologia Molecular, Avicultura e Fazenda Experimental da UDESC Oeste) do Centro de Educação Superior do Oeste/UDESC Chapecó/SC.

Uceff Faculdades - Chapecó - UCEFF**2015 - 2020** Vínculo: Celetista , Enquadramento funcional: Professor, Regime: Uceff Faculdades - Chapecó Parcial**Atividades****02/2015 - 12/2017** Graduação, Engenharia Civil*Disciplinas ministradas:*
*- Estatística.***06/2015 - 07/2016** Graduação, Engenharia Ambiental e Sanitária*Disciplinas ministradas:*
*- Estatística;***02/2015 - 07/2016** Graduação, Engenharia de Produção*Disciplinas ministradas:*
*- Química Geral Tecnológica.***07/2015 - 12/2015** Graduação, Engenharia Ambiental e Sanitária*Disciplinas ministradas:*
*Química Geral e Tecnológica***06/2015 - 12/2015** Graduação, Engenharia Elétrica*Disciplinas ministradas:*
*- Química Geral e Tecnológica.***07/2016 - 02/2020** Graduação, Engenharia Civil*Disciplinas ministradas:*
*Fenômenos de Transporte***07/2016 - 07/2017** Graduação, Engenharia Ambiental e Sanitária*Disciplinas ministradas:*
*Fenômenos de Transporte***07/2016 - 12/2016** Graduação, Engenharia de Produção*Disciplinas ministradas:*
*Estatística***02/2016 - 07/2016** Graduação, Engenharia Química*Disciplinas ministradas:*
*Química Geral e Inorgânica***07/2018 - 12/2018** Graduação, Engenharia Química*Disciplinas ministradas:*
*Físico-Química II***07/2018 - 12/2018** Graduação, Engenharia Ambiental e Sanitária*Disciplinas ministradas:*
*Tratamento de Esgoto Sanitário***02/2018 - 07/2018** Graduação, Engenharia Química*Disciplinas ministradas:*
*Físico-Química I***07/2019 - 12/2019** Graduação, Engenharia Química*Disciplinas ministradas:*
*Fenômenos de Transporte II***02/2019 - 07/2019** Graduação, Engenharia Química*Disciplinas ministradas:*
Fenômenos de Transporte I

Universidade Comunitária da Região de Chapecó - UNOCHAPECO

- 2014 - 2014** Vínculo: Professor contratado , Enquadramento funcional: Professor contratado , Carga horária: 12, Regime: Universidade Comunitária da Região de Chapecó Parcial
- 2020 - 2020** Vínculo: Professor contratado , Enquadramento funcional: Professor contratado , Carga horária: 12, Regime: Universidade Comunitária da Região de Chapecó Parcial
- 2023 - 2023** Vínculo: Professor contratado , Enquadramento funcional: Professor contratado , Carga horária: 12, Regime: Universidade Comunitária da Região de Chapecó Parcial

Atividades

10/2014 - 12/2014 Graduação, Engenharia Civil

Disciplinas ministradas:
- Estatística Inferencial.

10/2020 - 12/2020 Especialização

Especificação:
Metodologia da Pesquisa

04/2023 - 05/2023 Especialização

Especificação:
Bioestatística Básica

Universidade do Oeste de Santa Catarina - UNOESC

2014 - 2014 Vínculo: Professor contratado , Enquadramento funcional: Professor contratado , Carga horária: 12, Regime: Universidade do Oeste de Santa Catarina Parcial
Outras informações:

Atividades

10/2014 - 12/2014 Pós-graduação, Especialização em Controle de Qualidade em Aliment

Disciplinas ministradas:
- Biotecnologia e Biossegurança Aplicada em Alimentos.

Universidade Federal de Santa Catarina - UFSC

2012 - 2012 Vínculo: Pesquisador visitante , Enquadramento funcional: Estágio de doutorado , Carga horária: 40, Regime: Universidade Federal de Santa CatarinaDedicação exclusiva
Outras informações:
Departamento de Engenharia Química e Engenharia de Alimentos - Laboratório de Termodinâmica e Extração Supercrítica (LATESC). Bolsista CAPES.

2013 - 2013 Vínculo: Pesquisador visitante , Enquadramento funcional: Estágio de doutorado , Carga horária: 40, Regime: Universidade Federal de Santa CatarinaDedicação exclusiva
Outras informações:
Departamento de Engenharia Química e Engenharia de Alimentos - Laboratório de Termodinâmica e Extração Supercrítica (LATESC). Bolsista CAPES.

Universidade Federal do Rio Grande - FURG

2008 - 2010 Vínculo: Aluno de mestrado , Enquadramento funcional: Pesquisador , Carga horária: 40, Regime: Universidade Federal do Rio GrandeDedicação exclusiva

2008 - 2008 Vínculo: Aluno de mestrado , Enquadramento funcional: Estágio docência , Carga horária: 8, Regime: Universidade Federal do Rio GrandeDedicação exclusiva
Outras informações:
Ministrou aulas práticas na disciplina de Bioquímica Industrial para o curso de Engenharia Química da Universidade Federal do Rio Grande.

2010 - 2014 Vínculo: Aluno de doutorado , Enquadramento funcional: Pesquisador , Carga horária: 40, Regime: Universidade Federal do Rio GrandeDedicação exclusiva

2013 - 2013 Vínculo: Estágio docência , Enquadramento funcional: Estágio docência , Carga horária: 8, Regime: Universidade Federal do Rio GrandeDedicação exclusiva
Outras informações:
Aulas práticas e oficinas ministradas na disciplina de Bioquímica Industrial para o curso de Engenharia Química da Universidade Federal do Rio Grande.

Atividades

09/2008 - 10/2008 Graduação, Engenharia Química

Disciplinas ministradas:
Aulas Práticas de Bioquímica Industrial para o curso de Engenharia Química.

05/2013 - 08/2013 Graduação, Engenharia Química

Disciplinas ministradas:
Aulas práticas e oficinas ministradas na disciplina de Bioquímica Industrial para o curso de Engenharia Química.

Empresa Brasileira de Pesquisa Agropecuária - EMBRAPA

2007 - 2007 Vínculo: Institucional , Enquadramento funcional: Estágio , Carga horária: 40, Regime: Empresa Brasileira de Pesquisa AgropecuáriaDedicação exclusiva
Outras informações:
Estágio curricular de complementação educacional desenvolvido no laboratório de Controle de Qualidade, com atuação no Projeto Melhoramento genético de trigo para o agronegócio brasileiro.

Projetos

Projetos de pesquisa

2010 - 2014 Rede NANOFOTOTBIOTEC - Rede integradora de nanotecnologia e biotecnologia microalgal para o desenvolvimento científico/tecnológico e formação de recursos humanos

Descrição: Integrantes: Francisco Roberto da Silva Machado Junior - Integrante / Carlos André Veiga Burkert - Integrante / Jorge Alberto Vieira Costa - Coordenador. Financiador(es): Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Auxílio financeiro.
Situação: Concluído Natureza: Projetos de pesquisa
Alunos envolvidos: Graduação (12); Mestrado acadêmico (8); Doutorado (12);
Integrantes: Francisco Roberto da Silva Machado Junior; Carlos André Veiga Burkert; Jorge Alberto Vieira

Costa (Responsável)
Financiador(es): Coordenação de Aperfeiçoamento de Pessoal de Nível Superior-CAPEs

- 2010 - 2014** Encapsulamento de Agentes Bioativos e Imobilização de Enzimas em Nanoestruturas via Tecnologia Supercrítica (PRONEX - Edital FAPERGS/CNPq 008/2009)
- Situação: Concluído Natureza: Projetos de pesquisa
Alunos envolvidos: Doutorado (1);
Integrantes: Francisco Roberto da Silva Machado Junior; Carlos André Veiga Burkert; Janaina Fernandes de Medeiros Burkert; José Vladimir de Oliveira (Responsável)
- 2008 - 2010** Bioconversão da Glicerina Gerada na Síntese de Biodiesel em Biomassa Proteica
- Situação: Concluído Natureza: Projetos de pesquisa
Alunos envolvidos: Graduação (1); Mestrado acadêmico (2);
Integrantes: Francisco Roberto da Silva Machado Junior; BURKERT, CARLOS ANDRÉ V. (Responsável)
Financiador(es): FUNDAÇÃO DE AMPARO A PESQUISA DO ESTADO DO RIO GRANDE DO SUL-FAPERGS
- 2007 - 2007** Melhoramento genético de trigo para o agonegocio brasileiro
- Descrição: Estágio Curricular de Complementação Educacional
Situação: Concluído Natureza: Projetos de pesquisa
Alunos envolvidos: Graduação (2);
Integrantes: Francisco Roberto da Silva Machado Junior; Martha Zavariz de Miranda (Responsável)

Revisor de periódico

2020 - Atual International Research Journal of Pure and Applied Chemistry

Áreas de atuação

1. Grande área: Ciências Agrárias / Área: Ciência e Tecnologia de Alimentos
2. Grande área: Ciências Agrárias / Área: Ciência e Tecnologia de Alimentos
3. Grande área: Ciências Agrárias / Área: Ciência e Tecnologia de Alimentos
4. Grande área: Engenharias / Área: Engenharia Química
5. Grande área: Engenharias / Área: Engenharia de Produção
6. Grande área: Engenharias / Área: Engenharia Química

Produção

Produção bibliográfica

Citações

Web of Science

Total de trabalhos: 4

Total de citações: 160

Fator H: 4

Machado, Francisco R. S.; Machado Junior, F. R. S.

SCOPUS

Total de trabalhos: 5

Total de citações: 187

Machado, Francisco R. S.; Machado Junior, F. R. S.

Artigos completos publicados em periódicos

1.  DE MELLO, EMELINE PIZZOLATTO; BAJAY, MIKLOS MAXIMILIANO; DOS SANTOS, TAINARA LETICIA; DE JESUS, RENATO SANTOS; DEOLINDO, GUILHERME LUIZ; NORA, LUISA; TORTELLI, MARIO AUGUSTO; DA SILVA, GILNEI BRUNO; MANICA, DAIANE; BAGATINI, MARGARETE DULCE; MACHADO, FRANCISCO; DA SILVA, ALEKSANDRO S.. A Mixture of Free and Microencapsulated Essential Oils Combined with Turmeric and Tannin in the Diet of Dairy Cows: Effects on Productive Efficiency and Animal Health. *ANIMALS. JCR*, v.15, p.1588, 2025.
2.  DALCANTON, FRANCIELI; TOMBINI, CAROLINE; DE VARGAS, PAOLA FONTANA; TONETTO, MARIA LUIZA; LAJÚS, CRISTIANO RESCHKE; CAMINO FELTES, MARIA MANUELA; MACHADO JUNIOR, FRANCISCO. Upcycling of Brewer's Spent Grain in the Development and Characterization of Cookie-Type Biscuits. *NUTRITION & FOOD SCIENCE INTERNATIONAL JOURNAL*. v.14, p.1 - 10, 2025.
3.  BIANCHET, FERNANDA S.; MAISONNETT, LUIZ H.; ZANETTI, MICHEL; BREITENBACH, EVERTON R.; JUNIOR, FRANCISCO R.S. MACHADO; D. JOSIANE M.M.; MELLO, E; COSTELLA, MARCELO F.; DALCANTON, FRANCIELI. Processing of turkey breast and the implications of lean philosophy. *International Journal of Productivity and Quality Management*. v.40, p.120 - 147, 2023.
4.  TOMBINI, CAROLINE; GODOY, JANAYNE SANDER; MELLO, JOSIANE MARIA MUNERON; MACHADO JUNIOR, FRANCISCO ROBERTO DA SILVA; LAJÚS, CRISTIANO RESCHKE; COSTELLA, MARCELO FABIANO; DALCANTON, FRANCIELI. Análise da gestão do resíduo bagaço de malte em cervejarias da região oeste e extremo oeste do estado de Santa Catarina. *CONJECTURAS*. v.22, p.560 - 580, 2022.
5.  OTTO, EDUARDA; VAZATTA, EDUARDA CAROLINE; CAPELEZZO, LETÍCIA; MORAIS, THAINÁ; TOMBINI, CAROLINE; MACHADO JUNIOR, FRANCISCO ROBERTO DA SILVA; LAJÚS, CRISTIANO RESCHKE; CARLESSO, LIZIANE CASSIA; DALCANTON, FRANCIELI. Análise sensorial e nutricional de bolo tipo brownie de chocolate com ingredientes funcionais. *RESEARCH, SOCIETY AND DEVELOPMENT*. v.11, p.e423111335496, 2022.
6. VIVAN, A. C.; SAVOLDI, B. P.; MACHADO JUNIOR, F. R. S.; LAJUS, C. R.; LUZ, G. L.; ONOFRE, S. B.; DALCANTON, F.. AVALIAÇÃO DO TEMPO DE DESIDRATAÇÃO POR MICRO-ONDAS DE CHIPS DE BATATA YACON. *REVISTA TECNOLÓGICA (UEM)*. v.31, p.47 - 53, 2022.
7. FRIEDRICH, G. B.; MAI, S. C.; TOMBINI, C.; Godoy, J. S.; TERNUS, R. Z.; MACHADO JUNIOR, F. R. S.; DALCANTON, F.. CARACTERIZAÇÃO FÍSICO-QUÍMICA DE FARINHA DE ABÓBORA CABOTIÁ (TETSUKABUTO) INCORPORADA EM HAMBÚRGUER. *REVISTA TECNOLÓGICA (UEM)*. v.31, p.81 - 93, 2022.
8.  SILVA, VICENTE DAMO MARTINS DA; LUZ, ISABELLA TAUCHERT DA; GODOY, JANAYNE SANDER; LAJÚS, CRISTIANO RESCHKE; COLPANI, GUSTAVO LOPES; MELLO, JOSIANE MARIA

- MUNERON; **MACHADO JUNIOR, FRANCISCO ROBERTO DA SILVA**; DALCANTON, FRANCIELI. Desenvolvimento de cerveja estilo Catharina Sour de frutas vermelhas utilizando Lactobacillus plantarum. RESEARCH, SOCIETY AND DEVELOPMENT. v.11, p.e59111932009, 2022.
9.  **BALDI, EDUARDA**; TEIXEIRA, LAYLA; CUNHA, VINICIUS GABRIEL; TOMBINI, CAROLINE; BARICHELLO, RODRIGO; LUZ, GEAN LOPES DA; LAJÚS, CRISTIANO RESCHKE; **MACHADO JUNIOR, FRANCISCO ROBERTO DA SILVA**; DALCANTON, FRANCIELI. Análise do efeito da temperatura e do tratamento osmótico na desidratação de fatias de abacaxi. RESEARCH, SOCIETY AND DEVELOPMENT. v.10, p.e415101220157, 2021.
 10.  **VIEIRA, FERNANDA DE OLIVEIRA**; SANTOS, SUELEM VIEIRA DOS; TOMBINI, CAROLINE; MORATELLI, PRISCILA FAVERO; **MACHADO JUNIOR, FRANCISCO ROBERTO DA SILVA**; ZANETTI, MICHELI; DALCANTON, FRANCIELI. Elaboração, avaliação mercadológica e análise sensorial de pudim gelado sem lactose. RESEARCH, SOCIETY AND DEVELOPMENT. v.10, p.e49410615653, 2021.
 11.  **MELLO, JOSIANE M. M. DE**; **JUNIOR, FRANCISCO R. S. MACHADO**; BREITENBACH, EVERTON R.; ZANETTI, MICHELI; MAISONNETT, LUIZ HENRIQUE; SCHWANKE BIANCHET, FERNANDA; COSTELLA, MARCELO F.; DALCANTON, FRANCIELI. PROCESSING OF TURKEY CHEST AND THE IMPLICATIONS OF LEAN PHILOSOPHY. International Journal of Productivity and Quality Management. v.1, p.1, 2021.
 12.  **HALL, M. C.**; MARTELLI, E.; MENEGUZZI, C.; ZANETTI, M.; SILVA, L. L.; FIORI, M. A.; **MACHADO JUNIOR, F. R. S.**; MELLO, J. M. M.; DALCANTON, F.. Avaliação da atividade antimicrobiana dos óleos essenciais Nerol e Melaleuca puros e microencapsulados. Brazilian Journal of health Review. v.3, p.5331 - 5345, 2020.
 13.  **TOMBINI, CAROLINE**; AGNOL, JÉSSICA DALL; CAPELEZZO, LETÍCIA; GODOY, JANAYNE SANDER; **MACHADO JUNIOR, FRANCISCO ROBERTO DA SILVA**; LAJÚS, CRISTIANO RESCHKE; MELLO, JOSIANE MARIA MUNERON DE; DALCANTON, FRANCIELI. Desenvolvimento, caracterização físico-química e análise sensorial de pães integrais adicionados de resíduo da fabricação de cerveja estilo Pilsen e Porter. RESEARCH, SOCIETY AND DEVELOPMENT. v.9, p.e499119274, 2020.
 14.  **TOMBINI, CAROLINE**; **MACHADO JUNIOR, FRANCISCO ROBERTO DA SILVA**; DALCANTON, FRANCIELI. Diferentes metodologias de ensino em aula de controle de qualidade. RESEARCH, SOCIETY AND DEVELOPMENT. v.9, p.e4869108730, 2020.
 15.  **CAPELEZZO, LETÍCIA**; AGNOL, JÉSSICA DALL; TOMBINI, CAROLINE; GODOY, JANAYNE SANDER; ONOFFRE, SIDENEY BECKER; **MACHADO JUNIOR, FRANCISCO ROBERTO DA SILVA**; MELLO, JOSIANE MARIA MUNERON; DALCANTON, FRANCIELI. Elaboração e avaliação físico-química de uma barra de cereal utilizando resíduo cervejeiro. Brazilian Journal of Health Review. v.3, p.5107 - 5121, 2020.
 16.  **BIANCHET, FERNANDA SCHWANKE**; SBEGHEN, M. R.; SOUZA, C. J.; ZANETTI, M.; MELLO, J. M. M.; **MACHADO JUNIOR, F. R. S.**; COSTELLA, M. F.; DALCANTON, F. IMPLEMENTAÇÃO DE FERRAMENTAS DA FILOSOFIA LEAN EM UMA LINHA DE PEITO DE FRANGO IN NATURA. Revista ADM.MADE. v.24, p.55 - 74, 2020.
 17.  **BIANCHET, FERNANDA SCHWANKE**; ZANETTI, MICHELI; LAJÚS, CRISTIANO RESCHKE; **MACHADO JUNIOR, FRANCISCO ROBERTO DA SILVA**; COSTELLA, MARCELO FABIANO; MELLO, JOSIANE MARIA MUNERON; DALCANTON, FRANCIELI. Uso de ferramentas lean para melhoria de processos industriais alimentícios. Brazilian Journal of Health Review. v.3, p.5263 - 5277, 2020.
 18. ROSA, L. C. L.; BELLEI, P.; **MACHADO JUNIOR, F. R. S.**. GESTÃO DE PESSOAS COM OS GESTORES, FUNCIONÁRIOS E TERCEIRIZADOS EM TRÊS CONSTRUTORAS DE CHAPECÓ – SC. Latin American Journal of Business Management. v.10, p.143 - 156, 2019.
 19.  **REIS, DAIANE FELIX**; **MACHADO JUNIOR, FRANCISCO ROBERTO DA SILVA**; ORES, JOANA DA COSTA; LEMES, AILTON CESAR; BURKERT, CARLOS ANDRE VEIGA; BURKERT, JANAINA FERNANDES DE MEDEIROS. Influência do CO2 no Crescimento de Haematococcus Pluvialis e na Produção de Carotenoides. UNICIÊNCIAS (UNIC). v.22, p.25 - 29, 2019.
 20. CIOTTA, P. H.; **MACHADO JR, FRANCISCO R.S.**. A IMPORTÂNCIA DO CONTROLE DE QUALIDADE E RASTREABILIDADE DO CONCRETO ARMADO USINADO IN LOCO. TECNOLÓGICA - REVISTA CIENTÍFICA. v.7, p.1 - 18, 2018.
 21. VEZARO, E. D. A. N.; BARBISAN, A. O.; **MACHADO JR, FRANCISCO R.S.**. ANÁLISES COMPARATIVAS ENTRE CIMENTOS PORTLAND COMPOSTO (CP-II Z 32) COM ACOMPANHAMENTO POR MICROSCOPIA ELETRÔNICA DE VARREDURA – MEV. TECNOLÓGICA - REVISTA CIENTÍFICA. v.7, p.102 - 122, 2018.
 22.  **ORLANDI, GÉSSICA**; CAVASOTTO, JÉSSICA; **MACHADO, FRANCISCO R.S.**; COLPANI, GUSTAVO L.; MAGRO, JACIR DAL; DALCANTON, FRANCIELI; MELLO, JOSIANE M.M.; FIORI, MÁRCIO A.. An adsorbent with a high adsorption capacity obtained from the cellulose sludge of industrial residues. CHEMOSPHERE. **JCR**, v.169, p.171 - 180, 2017. **Citações:** **WEB OF SCIENCE** 42 | **SCOPUS** 46
 23. MELO, C. L.; SPOHR, G. M.; QUADROS, C. S.; FIDALSKI, G.; **MACHADO JR, FRANCISCO R.S.**; MELLO, J. M. M.; DALCANTON, F.. APLICAÇÃO DE RECOBRIMENTO DE FÉCULA DE BATATA PARA A CONSERVAÇÃO DE TOMATES. Revista Tecnológica. v.25, p.103 - 117, 2016.
 24.  **MACHADO, FRANCISCO R.S.**; TREVISOL, THALLES C.; BOSCHETTO, DAIANE L.; BURKERT, JANAINA F.M.; **FERREIRA, SANDRA R.S.**; **OLIVEIRA, J. VLADIMIR**; BURKERT, CARLOS ANDRÉ V.. Technological process for cell disruption, extraction and encapsulation of astaxanthin from Haematococcus pluvialis. Journal of Biotechnology. **JCR**, v.218, p.108 - 114, 2016. **Citações:** **WEB OF SCIENCE** 59 | **SCOPUS** 64
 25.  **MACHADO JUNIOR, F. R. S.**; MICHELON, M.; DALCANTON, F.; **FURLONG, E. B.**; **BURKERT, J. F. M.**; **BURKERT, C. A. V.**. Biomass production by Yarrowia lipolytica as a source of lipids: bench scale cultivation on raw glycerol-based medium. International Food Research Journal. **JCR**, v.22, p.1253 - 1260, 2015.
 26.  **MACHADO JR, FRANCISCO R.S.**; REIS, DAIANE F.; BOSCHETTO, DAIANE L.; BURKERT, JANAINA F.M.; **FERREIRA, SANDRA R.S.**; **OLIVEIRA, J. VLADIMIR**; BURKERT, CARLOS ANDRÉ V.. Encapsulation of astaxanthin from Haematococcus pluvialis in PHBV by means of SEDS technique using supercritical CO2. Industrial Crops and Products (Print). **JCR**, v.54, p.17 - 21, 2014. **Citações:** **WEB OF SCIENCE** 59 | **SCOPUS** 72
 27.  **COSTA, B. R.**; SILVA, R. S. G.; **MACHADO JUNIOR, F. R. S.**; COELHO, K. D.; **PINTO, L. A. A.**. Characterization of the fuji apple drying in thin layer: determination of glucose content, color and production. Vektor (FURG). v.20, p.92 - 108, 2010.

Capítulos de livros publicados

1. GODOY, J. S.; TOMBINI, C.; ZANETTI, M.; MELLO, J. M. M.; **MACHADO JUNIOR, F. R. S.**; DALCANTON, F.. MATERIAIS ANTIMICROBIANOS UTILIZADOS EM ALIMENTOS In: Materiais Antimicrobianos: Aspectos de Caracterizações Microbiológicas e de Aplicações, ed.1. Curitiba: Appris, 2025, v.1, p. 165 - 200.
2. ULLMANN, A. P.; OLIVEIRA, B. D.; MENEGUZZI, C.; OTTO, E.; CAMARGO, I. S.; TOMBINI, C.; **MACHADO JUNIOR, F. R. S.**; LAJUS, C. R.; DALCANTON, F.. APLICAÇÃO DO GEL DE LINHAÇA COMO SUBSTITUTO DO OVO PARA BOLO DO TIPO BROWNIE VEGANO In: Scientific research and health care. 1ed., ed.1., 2024, p. 219 - 233.
3. FROSI, A. R.; GIROTTI, S. I.; TOMBINI, CAROLINE; LAJÚS, CRISTIANO RESCHKE; **MACHADO JUNIOR, FRANCISCO ROBERTO DA SILVA**; DALCANTON, FRANCIELI. ELABORAÇÃO DE BARRA DE CEREAL INCORPORADA COM CASCA, POLPA E SEMENTE DE ABÓBORA CABOTIÁ In: CIÊNCIA E TECNOLOGIA DE ALIMENTOS: O AVANÇO DA CIÊNCIA NO BRASIL, ed.1. : Editora Científica Digital, 2023, v.3, p. 192 - 202.
4. ULLMANN, A. P.; ZACCARON, G.; LUZ, I. T.; TOMBINI, CAROLINE; LAJÚS, CRISTIANO RESCHKE; **MACHADO JUNIOR, FRANCISCO ROBERTO DA SILVA**; DALCANTON, FRANCIELI. ELABORAÇÃO DE QUEIJO VEGANO À BASE DE CASTANHA DE CAJU In: CIÊNCIA E TECNOLOGIA DE ALIMENTOS: O AVANÇO DA CIÊNCIA NO BRASIL, ed.1. : Editora Científica Digital, 2023, v.3, p. 203 - 211.

5. TOMBINI, C.; PAGNO, R. T.; DOMENICO, C. B.; OTTO, E.; GRANDO, A. A.; **MACHADO JUNIOR, F. R. S.**; ZANETTI, M.; DALCANTON, F. AVALIAÇÃO SENSORIAL DE GELEIA DE UVA COM ADIÇÃO DE ORA-PRO-NOBIS In: PESQUISAS E INOVAÇÕES EM ENGENHARIAS, CIÊNCIAS EXATAS E DA TERRA: PRODUÇÕES CIENTÍFICAS MULTIDISCIPLINARES NO SÉCULO XXI, ed.1. Rio de Janeiro: Instituto Scientia, 2022, v.2, p. 8 - 21.

Trabalhos publicados em anais de eventos (completo)

1. DALCANTON, F.; **MACHADO JUNIOR, F. R. S.**; LONGHI, D. A.; CARCIOFI, B. M. A.; LAURINDO, J. B.; ARAGAO, G. M. F. MATHEMATICAL MODELING OF LACTOBACILLUS VIRIDESCENS AND LACTOBACILLUS SAKAI GROWTH AT SIX DIFFERENT TEMPERATURES In: XX Congresso Brasileiro de Engenharia Química, 2014, Florianópolis - SC. **MATHEMATICAL MODELING OF LACTOBACILLUS VIRIDESCENS AND LACTOBACILLUS SAKAI GROWTH AT SIX DIFFERENT TEMPERATURES**. 2014.
2. REIS, D. F.; **MACHADO JUNIOR, F. R. S.**; OLIVEIRA, K. S. D.; TREVISOL, T. C.; REMEDI, R. D.; **BURKERT, C. A. V.**; **BURKERT, J. F. M.**. Crecimiento celular y producción de carotenoides de Haematococcus pluvialis en condiciones autotóficas y mixotóficas de cultivo en diferentes pHs In: IV Congreso Internacional de Ciencia y Tecnología de los Alimentos, 2012, Córdoba - Argentina. **Crecimiento celular y producción de carotenoides de Haematococcus pluvialis en condiciones autotóficas y mixotóficas de cultivo en diferentes pHs**. 2012.
3. **MACHADO JUNIOR, F. R. S.**; REIS, D. F.; OLIVEIRA, K. S. D.; TREVISOL, T. C.; **BURKERT, J. F. M.**; **BURKERT, C. A. V.**. Haematococcus pluvialis: Crescimento Celular e Extração de Carotenoides com Diferentes Solventes In: XIX Congresso Brasileiro de Engenharia Química, 2012, Búzios - RJ. **Haematococcus pluvialis: Crescimento Celular e Extração de Carotenoides com Diferentes Solventes**. 2012.
4. **MACHADO JUNIOR, F. R. S.**; MICHELON, M.; **BURKERT, C. A. V.**. Caracterização da Biomassa Obtida no Cultivo de Yarrowia Lipolytica NRRL YB-423 em Meio à Base de Glicerina Residual In: XVIII Simpósio Nacional de Bioprocessos, 2011, Caxias do Sul - RS. **Caracterização da Biomassa Obtida no Cultivo de Yarrowia Lipolytica NRRL YB-423 em Meio à Base de Glicerina Residual**. 2011.
5. **MACHADO JUNIOR, F. R. S.**; MICHELON, M.; **BURKERT, J. F. M.**; **BURKERT, C. A. V.**. Influência da Agitação e Aeração na Produção de Biomassa de Leveduras utilizando Glicerina Bruta gerada na Síntese Do Biodiesel In: XVIII Congresso Brasileiro de Engenharia Química, 2010, Foz do Iguaçu - PR. **Influência da Agitação e Aeração na Produção de Biomassa de Leveduras utilizando Glicerina Bruta gerada na Síntese Do Biodiesel**. 2010.
6. **PINTO, L. A. A.**; COSTA, B. R.; COELHO, K. D.; **MACHADO JUNIOR, F. R. S.**; SILVA, R. S. G. Caracterização da Secagem de Maça Fuji (Mallus pericae): Determinação do Teor de Glicose, da Cor e da Produção In: XVII Congresso Brasileiro de Engenharia Química, 2008, Recife - PE. **Caracterização da Secagem de Maça Fuji (Mallus pericae): Determinação do Teor de Glicose, da Cor e da Produção**. 2008.

Trabalhos publicados em anais de eventos (resumo)

1. PAGANI, A.; VARGAS, P. F.; TOMBINI, C.; FELTES, M. M. C.; **MACHADO JUNIOR, F. R. S.**; MELLO, J. M. M.; DALCANTON, F. Utilização do bagaço de malte na elaboração de biscoitos tipo cookies In: 10º Seminário Integrado de Ensino, Pesquisa, Extensão e Inovação da Unochapecó, 2021, Chapecó, SC. **10º Seminário Integrado de Ensino, Pesquisa, Extensão e Inovação da Unochapecó**. 2021.
2. DALCANTON, F.; BIANCHET, F. S.; **MACHADO JUNIOR, F. R. S.**; LAJUS, C. R.; ZANETTI, M.; COSTELLA, M. F.; MELLO, J. M. M.. USO DE FERRAMENTAS LEAN PARA MELHORIA DE PROCESSOS INDUSTRIAIS ALIMENTÍCIOS In: III SIMPÓSIO EM SAÚDE E ALIMENTAÇÃO DA UNIVERSIDADE FEDERAL DA FRONTEIRA SUL, 2019, Chapecó. **USO DE FERRAMENTAS LEAN PARA MELHORIA DE PROCESSOS INDUSTRIAIS ALIMENTÍCIOS**. 2019.
3. **MACHADO JUNIOR, F. R. S.**; MICHELON, M.; **BURKERT, C. A. V.**. Aproveitamento da Glicerina Bruta para Produção de Biomassa de Leveduras em Diferentes Temperaturas de Cultivo In: XXII Congresso Brasileiro de Ciência e Tecnologia de Alimentos, 2010, Salvador - BA. **Aproveitamento da Glicerina Bruta para Produção de Biomassa de Leveduras em Diferentes Temperaturas de Cultivo**. 2010.
4. CIPOLATTI, E.; **BURKERT, J. F. M.**; OTERO, D. M.; BORBA, T. M.; **MACHADO JUNIOR, F. R. S.**. Efeito do Congelamento na Medida do Sequestro de Radical Livre de Carotenoides extraídos de Biomassa de Phaffia Rhodozyma (NRRL-Y 17268) In: XXII Congresso Brasileiro de Ciência e Tecnologia de Alimentos, 2010, Salvador - BA. **Efeito do Congelamento na Medida do Sequestro de Radical Livre de Carotenoides extraídos de Biomassa de Phaffia Rhodozyma (NRRL-Y 17268)**. 2010.
5. OTERO, D. M.; **BURKERT, J. F. M.**; BORBA, T. M.; CIPOLATTI, E.; **MACHADO JUNIOR, F. R. S.**. Influência do Diâmetro da Partícula e do Tempo de Congelamento da Biomassa na Recuperação de Carotenoides produzidos por Phaffia Rhodozyma In: XXII Congresso Brasileiro de Ciência e Tecnologia de Alimentos, 2010, Salvador - BA. **Influência do Diâmetro da Partícula e do Tempo de Congelamento da Biomassa na Recuperação de Carotenoides produzidos por Phaffia Rhodozyma**. 2010.

Trabalhos publicados em anais de eventos (resumo expandido)

1. TREVISOL, T. C.; **MACHADO JUNIOR, F. R. S.**; REIS, D. F.; **BURKERT, J. F. M.**; **BURKERT, C. A. V.**. Extração de Carotenoides de Haematococcus pluvialis por diferentes Métodos de Ruptura Celular In: 12ª Mostra da Produção Universitária, 2013, Rio Grande - RS. **Extração de Carotenoides de Haematococcus pluvialis por diferentes Métodos de Ruptura Celular**. 2013.
2. REIS, D. F.; **MACHADO JUNIOR, F. R. S.**; OLIVEIRA, K. S. D.; TREVISOL, T. C.; **BURKERT, C. A. V.**; **BURKERT, J. F. M.**. Haematococcus pluvialis: Crescimento Celular e Produção Carotenogênica em Diferentes Meios de Cultivo In: XIII Encontro de Pós-Graduação, 2011, Pelotas - RS. **Haematococcus pluvialis: Crescimento Celular e Produção Carotenogênica em Diferentes Meios de Cultivo**. 2011.
3. **MACHADO JUNIOR, F. R. S.**; **BURKERT, C. A. V.**. Conversão por Via Biotecnológica da Glicerina Gerada na Síntese de Biodiesel em Biomassa de Leveduras In: XI Encontro de Pós-Graduação, 2009, Rio Grande - RS. **Conversão por Via Biotecnológica da Glicerina Gerada na Síntese de Biodiesel em Biomassa de Leveduras**. 2009.
4. **MACHADO JUNIOR, F. R. S.**; MICHELON, M.; **BURKERT, J. F. M.**; **BURKERT, C. A. V.**. Influência da Composição do Meio de Inóculo e da Temperatura na Produção de Biomassa de Leveduras a Partir da Glicerina Bruta In: I Seminário sobre Biodiesel e Coprodutos, 2009, Campinas - SP. **Influência da Composição do Meio de Inóculo e da Temperatura na Produção de Biomassa de Leveduras a Partir da Glicerina Bruta**. 2009.
5. COSTA, B. R.; COELHO, K. D.; **MACHADO JUNIOR, F. R. S.**; SILVA, R. S. G.; **PINTO, L. A. A.**. Secagem de Maça Fuji (Mallus pericae) em Camada Delgada para produção de "Chips" In: VI Mostra de Produção Universitária, 2007, Rio Grande - RS. **Secagem de Maça Fuji (Mallus pericae) em Camada Delgada para produção de "Chips"**. 2007.

Apresentação de trabalho e palestra

1. **MACHADO JUNIOR, F. R. S.**; **BURKERT, C. A. V.**. Conversão por Via Biotecnológica da Glicerina Gerada na Síntese de Biodiesel em Biomassa de Leveduras, 2009. (Outra, Apresentação de Trabalho)
2. **MACHADO JUNIOR, F. R. S.**; MICHELON, M.; **BURKERT, J. F. M.**; **BURKERT, C. A. V.**. Influência da Composição do Meio de Inóculo e da Temperatura na Produção de Biomassa de Leveduras a Partir da Glicerina Bruta, 2009. (Seminário, Apresentação de Trabalho)
3. SILVA, R. S. G.; COSTA, B. R.; COELHO, K. D.; **MACHADO JUNIOR, F. R. S.**. Secagem de maçã fuji (Mallus pericae) em camada delgada para a produção de, 2007. (Congresso, Apresentação de Trabalho)

Orientações e Supervisões

Orientações e supervisões

Orientações e supervisões concluídas

Trabalhos de conclusão de curso de graduação

1. Cleidi Cristina Penz. **Diagnóstico da qualidade da água em poços de sistema alternativo coletivo na cidade de Chapecó/SC**. 2019. Curso (Engenharia Ambiental e Sanitária) - Uceff Faculdades - Chapecó
2. Juliana Salete Guarda. **Possíveis causas da ecotoxicidade em efluentes de uma indústria cafeeira localizada o Estado do Paraná**. 2019. Curso (Engenharia Ambiental e Sanitária) - Uceff Faculdades - Chapecó
3. Odair Kommers. **Viabilidade da utilização da cinza da madeira de eucalipto na correção de pH e no tratamento físico-químico de efluente agroindustrial**. 2019. Curso (Engenharia Ambiental e Sanitária) - Uceff Faculdades - Chapecó
4. Raíssa Chernhak. **Análise da avaliação de retrorefletância de uma obra de sinalização viária vertical e horizontal em Santa Catarina**. 2018. Curso (Engenharia Civil) - Uceff Faculdades - Chapecó
5. Augusto Brighenti. **Análise da acessibilidade na galeria centro comercial Fernando Machado de Chapecó/SC**. 2017. Curso (Engenharia Civil) - Uceff Faculdades - Chapecó
6. João Manoel Balestrin. **Análise da produção e resistência mecânica à compressão do concreto, conforme as especificações do projeto de uma obra localizada em Chapecó/SC**. 2016. Curso (Engenharia Civil) - Uceff Faculdades - Chapecó
7. Greici Marasca Schneider. **Avaliação da qualidade do leite in natura por meio de análises físico-químicas e de fraudes**. 2016. Curso (Tecnologia em Alimentos) - Faculdades de Itapiranga
8. Adriani Luiza Linn. **Avaliação da resistência térmica de cepas de Escherichia coli isoladas em uma indústria do extremo oeste catarinense**. 2016. Curso (Tecnologia em Alimentos) - Faculdades de Itapiranga
9. Rafael Gheller. **Caracterização de polímeros incorporados com fibras lignocelulósicas com possível aplicação na construção civil**. 2016. Curso (Engenharia Civil) - Faculdade Empresarial de Chapecó
10. Iara Thaís Wermuth. **Procedimentos Padrão Operacional no setor de espóstejamento de uma indústria de suínos do oeste catarinense**. 2016. Curso (Tecnologia em Alimentos) - Faculdades de Itapiranga
11.  Pablo Henrique Ciotta. **A importância do controle de qualidade e rastreabilidade do concreto armado usinado in loco**. 2015. Curso (Engenharia Civil) - Faculdade Empresarial de Chapecó
12.  Elizeu Domingos Antonioli Neto Vezaro. **Análises comparativas entre cimentos portland composto (CP-II Z 32) com acompanhamento por microscopia eletrônica de varredura (MEV)**. 2015. Curso (Engenharia Civil) - Faculdade Empresarial de Chapecó
13.  Elan Antonio Almeida. **Patologias em pavimentos flexíveis**. 2015. Curso (Engenharia Civil) - Faculdade Empresarial de Chapecó

Iniciação científica

1.  Thaltes Canton Trevisol. **Encapsulamento de Astaxantina Produzida por Microalgas**. 2010. Iniciação científica (Engenharia Bioquímica) - Universidade Federal do Rio Grande. Inst. financiadora: Coordenação de Aperfeiçoamento de Pessoal de Nível Superior
2. Mariano Michelon. **Conversão por Via Biotecnológica de Glicerina Residual em Biomassa de Leveduras como fonte de Proteínas e Lipídios**. 2008. Iniciação científica (Engenharia de Alimentos) - Universidade Federal do Rio Grande. Inst. financiadora: Conselho Nacional de Desenvolvimento Científico e Tecnológico

Eventos

Eventos

Participação em eventos

1. Apresentação de Poster / Painel no(a) **XX Congresso Brasileiro de Engenharia Química**, 2014. (Congresso) MATHEMATICAL MODELING OF LACTOBACILLUS VIRIDESCENS AND LACTOBACILLUS SAKÉI GROWTH AT SIX DIFFERENT TEMPERATURES.
2. Apresentação de Poster / Painel no(a) **XIX Congresso Brasileiro de Engenharia Química**, 2012. (Congresso) Haematococcus pluvialis: Crescimento Celular e Extração de Carotenoides com Diferentes Solventes.
3. **Ciclo de Palestras**, 2011. (Outra) .
4. Apresentação de Poster / Painel no(a) **XXII Congresso Brasileiro de Ciência e Tecnologia de Alimentos**, 2010. (Congresso) Efeito do Congelamento na Medida do Sequestro de Radical Livre de Carotenoides extraídos de Biomassa de Phaffia Rhodozyma (NRRL-Y 17268).
5. Apresentação de Poster / Painel no(a) **XXII Congresso Brasileiro de Ciência e Tecnologia de Alimentos**, 2010. (Congresso) Aproveitamento da Glicerina Bruta para Produção de Biomassa de Leveduras em Diferentes Temperaturas de Cultivo.
6. Apresentação de Poster / Painel no(a) **XXII Congresso Brasileiro de Ciência e Tecnologia de Alimentos**, 2010. (Congresso) Influência do Diâmetro da Partícula e do Tempo de Congelamento da Biomassa na Recuperação de Carotenoides produzidos por Phaffia Rhodozyma.
7. Apresentação de Poster / Painel no(a) **I Seminário Sobre Biodiesel e Coprodutos**, 2009. (Seminário) Influência da Composição do Meio de Inóculo e da Temperatura na Produção de Biomassa de Leveduras a Partir da Glicerina Bruta.
8. Apresentação Oral no(a) **VIII Mostra da Produção Universitária**, 2009. (Outra) Conversão por Via Biotecnológica da Glicerina Gerada na Síntese de Biodiesel em Biomassa de Leveduras.
9. Apresentação Oral no(a) **XI Encontro de Pós-Graduação**, 2009. (Encontro) Conversão por Via Biotecnológica da Glicerina Gerada na Síntese de Biodiesel em Biomassa de Leveduras.
10. **26ª SEMALIM - Semana de Engenharia de Alimentos**, 2007. (Outra) .
11. **9ª Semana Acadêmica de Engenharia de Alimentos da FURG**, 2005. (Outra) .
12. **I Fórum das Indústrias do RS - Encontro das Empresas Cerealistas**, 2005. (Encontro) .
13. **II Fórum das Indústrias do RS - Encontro das Empresas de Carnes**, 2005. (Outra) .
14. **23ª SEMALIM - Semana de Engenharia de Alimentos**, 2004. (Outra) .

Organização de evento

1. **MACHADO JUNIOR, F. R. S.**. XI Encontro de Pós-Graduação, 2009. (Outro, Organização de evento)
2. **MACHADO JUNIOR, F. R. S.**. 8ª Semana Acadêmica de Engenharia de Alimentos da FURG, 2003. (Outro, Organização de evento)
3. **MACHADO JUNIOR, F. R. S.**. Fiscal do Processo Seletivo da FURG, 2002. (Outro, Organização de evento)
4. **MACHADO JUNIOR, F. R. S.**. Fiscal do Processo Seletivo da FURG, 2001. (Outro, Organização de evento)

Bancas

Bancas

Participação em banca de trabalhos de conclusão

Mestrado

1. MELLO, J. M. M.; DALCANTON, F.; FIORI, MÁRCIO A.; **MACHADO JUNIOR, F. R. S.**; TERNUS, R. Z.. Participação em banca de Rosana da Silva. **Avaliação da atividade antimicrobiana de ração para frango aditivada de nanopartículas de óxido de zinco**, 2017. (Tecnologia e Gestão da Inovação) Universidade Comunitária da Região de Chapecó.

Graduação

1. **MACHADO JUNIOR, F. R. S.**; Piletti, R.; BASSANI, M. T.. Participação em banca de Greici Marasca Schneider. **Avaliação da qualidade do leite in natura por meio de análises físico-químicas e de fraudes**, 2016. (Tecnologia em Alimentos) Faculdades de Itapiranga.
2. BASSANI, M. T.; **MACHADO JUNIOR, F. R. S.**; Piletti, R.. Participação em banca de Nádia Hahn. **Avaliação da qualidade físico-químicas e pesquisa de fraudes no leite cru refrigerado**, 2016. (Tecnologia em Alimentos) Faculdades de Itapiranga.
3. **MACHADO JUNIOR, F. R. S.**; Piletti, R.; BASSANI, M. T.. Participação em banca de Adriani Luiza Linn. **Avaliação da resistência térmica de cepas de Escherichia coli isoladas em uma indústria do extremo oeste catarinense**, 2016. (Tecnologia em Alimentos) Faculdades de Itapiranga.
4. BELLEI, P.; **MACHADO JUNIOR, F. R. S.**; CARNEIRO, M. F. W.. Participação em banca de Genilson Fabrizio. **Avaliação do desempenho do concreto auto-adensável com adição de cinza de biomassa vegetal**, 2016. (Engenharia Civil) Faculdade Empresarial de Chapecó.
5. MOTTER, L.; **MACHADO JR, FRANCISCO R.S.**; CARNEIRO, M. F. W.. Participação em banca de Tiago Junior Fachini. **Captação e aproveitamento de água da chuva para fins não potáveis de forma sustentável e de baixo custo**, 2016. (Engenharia Civil) Uceff Faculdades - Chapecó.
6. BELLEI, P.; **MACHADO JUNIOR, F. R. S.**; BENETTI, J. L.. Participação em banca de Adriano Adilson Potte. **Estudo comparativo entre lajes treliçadas com enchimento de EPS, nervuradas com forma plástica tipo cubeta e lajes de formas colaborantes nervuradas (mistas nervuradas)**, 2016. (Engenharia Civil) Faculdade Empresarial de Chapecó.
7. MOTTER, L.; **MACHADO JR, FRANCISCO R.S.**; CARNEIRO, M. F. W.. Participação em banca de Douglas Pires dos Santos. **Estudo da viabilidade técnica e econômica da implantação de um sistema de aquecimento solar residencial em Chapecó/SC**, 2016. (Engenharia Civil) Uceff Faculdades - Chapecó.
8. BELLEI, P.; **MACHADO JUNIOR, F. R. S.**; BENETTI, J. L.. Participação em banca de Ricardo de Moura. **Estudo sobre o concreto translúcido na forma estrutural e estética na construção civil**, 2016. (Engenharia Civil) Faculdade Empresarial de Chapecó.
9. **MACHADO JUNIOR, F. R. S.**; Piletti, R.; BASSANI, M. T.. Participação em banca de Iara Thaís Wermuth. **Procedimentos Padrão Operacional no setor de espójeamento de uma indústria de suínos do oeste catarinense**, 2016. (Tecnologia em Alimentos) Faculdades de Itapiranga.
10. **MACHADO JUNIOR, F. R. S.**; TRAVI, M. R. L.; ANSCHAU, C. T.. Participação em banca de Pablo Henrique Ciotta. **A importância do controle de qualidade e rastreabilidade do concreto armado usinado in loco**, 2015. (Engenharia Civil) Faculdade Empresarial de Chapecó.
11. **MACHADO JUNIOR, F. R. S.**; TRAVI, M. R. L.; BELLEI, P.. Participação em banca de Elizeu Domingos Antoniloli Neto Vezaro. **Análises comparativas entre cimentos portland composto (CP-II Z 32) com acompanhamento por microscopia eletrônica de varredura (MEV)**, 2015. (Engenharia Civil) Faculdade Empresarial de Chapecó.
12. ANSCHAU, C. T.; **MACHADO JUNIOR, F. R. S.**; TRAVI, M. R. L.. Participação em banca de Rafael Matheus Tibes. **Melhoramento do traço de argamassa para estaca raiz**, 2015. (Engenharia Civil) Faculdade Empresarial de Chapecó.
13. **MACHADO JUNIOR, F. R. S.**; BENETTI, J. L.; BELLEI, P.. Participação em banca de Elan Antonio Almeida. **Patologias em pavimentos flexíveis**, 2015. (Engenharia Civil) Faculdade Empresarial de Chapecó.
14. BELLEI, P.; **MACHADO JUNIOR, F. R. S.**; CARNEIRO, M. F. W.. Participação em banca de Jaison Pereira. **Patologias nos pisos de uma agroindústria localizada em Chapecó - SC**, 2015. (Engenharia Civil) Faculdade Empresarial de Chapecó.

Totais de produção

Produção bibliográfica

Artigos completos publicados em periódico	27
Capítulos de livros publicados	5
Trabalhos publicados em anais de eventos	16
Apresentações de trabalhos (Congresso)	1
Apresentações de trabalhos (Seminário)	1
Apresentações de trabalhos (Outra)	1

Produção técnica

Outra produção técnica	2
------------------------	---

Orientações

Orientação concluída (trabalho de conclusão de curso de graduação)	13
--	----

Orientação concluída (iniciação científica)	2
Eventos	
Participações em eventos (congresso)	5
Participações em eventos (seminário)	1
Participações em eventos (encontro)	2
Participações em eventos (outra)	6
Organização de evento (outro)	4
Participação em banca de trabalhos de conclusão (mestrado)	1
Participação em banca de trabalhos de conclusão (graduação)	14

Página gerada pelo sistema Currículo Lattes em 19/01/2026 às 12:38:29.