



# A Face Multidisciplinar das Ciências Agrárias 4

Raissa Rachel Salustriano da Silva-Matos  
Hosana Aguiar Freitas de Andrade  
Nítalo André Farias Machado  
(Organizadores)

 **Atena**  
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Ano 2019



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## APRESENTAÇÃO

Nos primórdios do desenvolvimento da agricultura, os recursos naturais disponíveis propiciaram o surgimento das atividades agropecuárias, e desta forma, a necessidade de atuação dos profissionais de ciências agrárias tornou-se consolidada. Durante séculos, novos conhecimentos foram adquiridos, fundamentados teoricamente sobre as práticas agrícolas, conduzindo ao aperfeiçoamento do processo produtivo de acordo com a evolução da sociedade.

Diante do atual cenário, a obra “A Face Multidisciplinar das Ciências Agrárias” em seus volumes 3 e 4 engloba respectivamente 24 e 27 capítulos capazes de possibilitar ao leitor a experiência de ampliar o conhecimento sobre a economia e sociologia no campo, conservação pós-colheita, tecnologia de alimentos, produção vegetal, qualidade de produtos agropecuários, metodologias de ensino e extensão nas escolas, epidemiologia e cadeia produtiva da produção animal.

Em virtude da pluralidade existente desta grande área, os trabalhos apresentados abordam temas de expressiva importância as questões sociais e econômicas do Brasil. E, portanto, evidenciamos profunda gratidão pelo empenho dos autores, que em conjunto, contribuíram para o desenvolvimento e formação deste e-book.

Espera-se, agregar ao leitor, conhecimentos sobre a multidisciplinaridade das ciências agrárias, de modo a atender as crescentes demandas por alimentos primários e transformados, preservando o meio ambiente para às gerações futuras.

Raissa Rachel Salustriano da Silva-Matos  
Hosana Aguiar Freitas de Andrade  
Nítalo André Farias Machado

## SUMÁRIO

|   |           |
|---|-----------|
| <b>CAPÍTULO 1</b> .....   | <b>1</b>  |
| A DESTINAÇÃO DE RECURSOS ORÇAMENTÁRIOS PARA POLÍTICAS PÚBLICAS E INOVAÇÃO NO ÂMBITO DO AGRONEGÓCIO NO MUNICÍPIO DE ANCHIETA – ES NO PERÍODO DE 2013 A 2017  |           |
| César Albenes de Mendonça Cruz<br>Denise Ferreira Pinto Paterlini<br>Eliaidina Wagna Oliveira da Silva<br>Marcelo da Fonseca Ferreira da Silva<br>Marcelo Plotegher Campinhos<br>Maria José Coelho dos Santos |           |
| <b>DOI 10.22533/at.ed.8851923121</b>  |           |
| <b>CAPÍTULO 2</b> .....   | <b>16</b> |
| APLICAÇÃO DA MATRIZ SWOT PARA IDENTIFICAR FRAQUEZAS INTERNAS POTENCIAIS DE UMA LOJA DE PRODUTOS AGROPECUÁRIOS NO SERTÃO CENTRAL DO CEARÁ  |           |
| Emanuela Bento de Lima<br>Rildson Melo Fontenele<br>Antonio Geovane de Moraes Andrade<br>José Willamy Ribeiro Marques<br>Cláudio Mateus Pereira da Silva  |           |
| <b>DOI 10.22533/at.ed.8851923122</b>  |           |
| <b>CAPÍTULO 3</b> .....   | <b>20</b> |
| APLICAÇÃO DE ADJUVANTES E ULTRASSOM NA EXTRAÇÃO DO AZEITE DE OLIVA  |           |
| Diegho Andrade Paz<br>Cássio Delgado Salim<br>Raphael Veloso Gusmão Silva<br>Candice Soares Dias<br>Marcilio Machado Moraes<br>Valéria Terra Crexi  |           |
| <b>DOI 10.22533/at.ed.8851923123</b>  |           |
| <b>CAPÍTULO 4</b> .....   | <b>31</b> |
| APLICAÇÃO DE BAGAÇO DE MAÇÃ NA PRODUÇÃO DE BISCOITOS TIPO <i>COOKIES</i>  |           |
| Beatriz Cervejeira Bolanho Barros<br>Suelen Pereira Ruiz Herrig<br>Otávio Akira Sakai<br>Keila Fernanda Raimundo<br>Luana Mariani Jorge   |           |
| <b>DOI 10.22533/at.ed.8851923124</b>  |           |
| <b>CAPÍTULO 5</b> .....   | <b>43</b> |
| AVALIAÇÃO DA ATIVIDADE ANTIBACTERIANA DE COMPOSTOS NATURAIS FRENTE A CEPAS PADRÃO   |           |
| Giovana Hashimoto Nakadomari<br>Lucas Valeiras Gaddini<br>Sheila Rezler Wosiacki  |           |
| <b>DOI 10.22533/at.ed.8851923125</b>  |           |

**CAPÍTULO 6 ..... 50**

AVALIAÇÃO DE FORMULAÇÕES DE BISCOITOS COM ADIÇÃO DE FARINHA DE RESÍDUOS DE BANANEIRA E FÉCULA DE MANDIOCA UTILIZANDO PLANEJAMENTO FATORIAL

Isabella Fernanda Camargo Queiroz

Kate Mariane Adensuloye

Mariana Manfroi Fuzinato

**DOI 10.22533/at.ed.8851923126**

**CAPÍTULO 7 ..... 62**

CARACTERIZAÇÃO DE COMPOSTOS BIOATIVOS E ATIVIDADE ANTIOXIDANTE DE AMORAPRETA DA CULTIVAR 'TUPY' PRODUZIDAS NO OESTE DE SANTA CATARINA

Cintia Dos Santos Moser

Adriana Lugaresi

Alison Uberti

Felipe Tecchio Borsoi

Clevison Luiz Giacobbo

Margarete Dulce Bagatini

**DOI 10.22533/at.ed.8851923127**

**CAPÍTULO 8 ..... 67**

CARACTERIZAÇÃO FITOQUÍMICA DOS EXTRATOS BRUTO E AQUOSO DA POLPA E DA CASCA DE PITAYA VERMELHA (*HYLOCEREUS POLYRHIZUS*)

Sandra Machado Lira

Lia Corrêa Coelho

Chayane Gomes Marques

Marcelo Oliveira Holanda

Juliana Barbosa Dantas

Ana Carolina Viana de Lima

Glauber Batista Moreira Santos

Gisele Silvestre da Silva

Fernando Antônio Pinto de Abreu

Ana Paula Dionísio

Guilherme Julião Zocolo

Maria Izabel Florindo Guedes

**DOI 10.22533/at.ed.8851923128**

**CAPÍTULO 9 ..... 79**

CINÉTICA DA SECAGEM DE AQUÊNIOS DE GIRASSOL

Gustavo Soares Wenneck

Reni Saath

Larissa Leite de Araújo

Camila de Souza Volpato

Danilo Cesar Santi

**DOI 10.22533/at.ed.8851923129**

**CAPÍTULO 10 ..... 91**

UTILIZAÇÃO DOS RESÍDUOS DE PANIFICAÇÃO NO PROCESSAMENTO DE RAÇÃO ANIMAL PELETIZADA

Lúcia de Fátima Araújo

Emerson Moreira Aguiar

Robson Rogério Pessoa Coelho

João Carlos Taveira

Luiz Eduardo Santiago

**DOI 10.22533/at.ed.88519231210**

**CAPÍTULO 11 ..... 101**

COMERCIALIZAÇÃO DE PRODUTOS DA AGRICULTURA FAMILIAR LOCAL NA FEIRA LIVRE DE CAMETÁ, PARÁ

Ana Clara Rodrigues de Sousa Leite  
Josiele Pantoja de Andrade  
Diego Coelho Leite  
Fagner Freires de Sousa

**DOI 10.22533/at.ed.88519231211**

**CAPÍTULO 12 ..... 116**

COMPOSIÇÃO FLORÍSTICA E ESTRUTURAL DE UM FRAGMENTO DE CERRADO *SENSU STRICTO* EM DIANÓPOLIS-TO

Pedro James Almeida Wolney  
Luan Bonfim Rosa Teixeira  
Tamara Thalia Prolo  
Virgílio Lourenço da Silva Neto  
Maria Adriana Santos Carvalho  
Elismar Dias Batista  
Rômulo Quirino de Souza Ferreira

**DOI 10.22533/at.ed.88519231212**

**CAPÍTULO 13 ..... 126**

DESAFIOS DA AGRICULTURA FAMILIAR EM PRÓL DA PRODUÇÃO AGROECOLÓGICA EM TANGARÁ DA SERRA – MT

Regina Maria da Costa  
Aparecida de Fátima Alves Lima

**DOI 10.22533/at.ed.88519231213**

**CAPÍTULO 14 ..... 139**

EL MODELO DE PRODUCCIÓN-DISTRIBUCIÓN-CONSUMO (P-D-C) AGROECOLÓGICO EN EL TERRITORIO

Mónica de Nicola  
Maria Elena Díaz Aradas  
Adhemar Pascualle  
Teresa Questa

**DOI 10.22533/at.ed.88519231214**

**CAPÍTULO 15 ..... 154**

EN BÚSQUEDA DE UNA ORGANIZACIÓN PRODUCTIVA PARA LOS ARTESANOS DEL BUTIÁ DE SANTA VITÓRIA DO PALMAR (RS), BRASIL

Laura Bibiana Boada Bilhalva  
Cristiano Ruiz Engelke

**DOI 10.22533/at.ed.88519231215**

**CAPÍTULO 16 ..... 160**

ESTIMATIVA DO FILOCRONO E SOMA TÉRMICA DO TRIGO DUPLO PROPÓSITO EM SÃO VICENTE DO SUL

Fernando Saraiva Silveira Júnior  
Ivan Carlos Maldaner  
Victor Paulo Kloeckner Pires  
Marcos Antonio Turchiello  
Camila Lima Leocadio  
Fabrício Penteadado Carvalho  
Willian Luis Castro Vicente



Murilo Brum de Moura  
Henrique Shaf Eggers  
DOI 10.22533/at.ed.88519231216

**CAPÍTULO 17 ..... 168**

ESTUDO DA CINÉTICA DE ADSORÇÃO DO CORANTE AZUL REATIVO 5G EM CASCA DE SOJA

Gabriela Souza Alves  
Claudinéia Queli Geraldi  
Rubén Francisco Gauto

DOI 10.22533/at.ed.88519231217

**CAPÍTULO 18 ..... 175**

INFLUÊNCIA DA EMBALAGEM E AMBIENTE NA CONSERVAÇÃO PÓS-COLHEITA DE FRUTOS DE RAMBUTAN (*Nephelium lappaceum* L.)

Brenda Karina Rodrigues da Silva  
Artur Vinícius Ferreira dos Santos  
Antonia Benedita da Silva Bronze  
Sinara de Nazaré Santana Brito  
Harleson Sidney Almeida Monteiro  
Thayane Ferreira Miranda  
Danilo da Luz Melo  
Wenderson Nonato Ferreira da Conceição  
Meirevalda do Socorro Ferreira Redig  
João Almiro Corrêa Soares

DOI 10.22533/at.ed.88519231218

**CAPÍTULO 19 ..... 186**

LA AGRICULTURA FAMILIAR Y SU RELACIÓN CON LOS SISTEMAS EXPERTOS. UNA MIRADA DESDE LA EXTENSIÓN

María Sergia Villaberde  
Leandro Sabanes  
Amparo Heguiabehere  
María Andrea Porporato  
Érica Funes

DOI 10.22533/at.ed.88519231219

**CAPÍTULO 20 ..... 198**

LAS POLÍTICAS FORESTALES ARGENTINAS EN LA CONSTITUCIÓN DEL DELTA INFERIOR BONAERENSE COMO REGIÓN FORESTAL

Carlos Javier Moreira

DOI 10.22533/at.ed.88519231220

**CAPÍTULO 21 ..... 217**

MODELOS DE ÁRVORE INDIVIDUAL NA ESTIMATIVA DO CRESCIMENTO E PRODUÇÃO FLORESTAL

Lorena Oliveira Barbosa  
Verônica Satomi Kazama  
Anny Francielly Ataíde Gonçalves  
Luciano Cavalcante de Jesus França  
José Roberto Soares Scolforo

DOI 10.22533/at.ed.88519231221

**CAPÍTULO 22 ..... 230**

O RURAL ENVOLVENDO DIMENSÕES ECONÔMICAS E NÃO ECONÔMICAS: PROCESSOS DE DESENVOLVIMENTO DEPENDENTES DAS DINÂMICAS DE ENVOLVIMENTO DAS COMUNIDADES

Cláudio Machado Maia  
Mario Riedl  
Cláudia Susana Marques Antunes  
Ana Laura Vianna Villela  
Rosa Salete Alba

**DOI 10.22533/at.ed.88519231222**

**CAPÍTULO 23 ..... 244**

PERCEPÇÃO DISCENTE DAS METODOLOGIAS DE ENSINO E MONITORIA NA DISCIPLINA DE SUINOCULTURA DO CURSO DE VETERINÁRIA DA UNIVERSIDADE ESTADUAL DO CEARÁ

Lina Raquel Santos Araújo  
Deborah Marrocos Sampaio Vasconcelos  
Ênio Campos da Silva  
Fágner Cavalcante Patrocínio dos Santos  
Victor Hugo Vieira Rodrigues  
Everton Nogueira Silva  
José Nailton Bezerra Evangelista

**DOI 10.22533/at.ed.88519231223**

**CAPÍTULO 24 ..... 252**

PERSPECTIVAS INSTITUCIONAIS DE CONTROLE E FISCALIZAÇÃO DE ALIMENTOS EM SANTA MARIA/RS

Valéria Pinheiro Braccini  
Luis Fernando Vilani de Pellegrini  
Janaina Balk Brandão

**DOI 10.22533/at.ed.88519231224**

**CAPÍTULO 25 ..... 263**

PRODUÇÃO DE FERMENTADO ALCOÓLICO A PARTIR DA POLPA DE BURITI (*Mauritia flexuosa* L. f.)

Marco Antônio de Alcântara Rocha  
Wenderson Gomes dos Santos  
Douglas Alberto Rocha de Castro

**DOI 10.22533/at.ed.88519231225**

**CAPÍTULO 26 ..... 276**

SABERES AMBIENTAIS E AGRICULTURA ORGÂNICA: EXPERIÊNCIAS COMPARTILHADAS EM UMA FEIRA AGROECOLÓGICA NA REGIÃO AMAZÔNICA

Mailson Lima Nazaré  
Raimundo Paulo Monteiro Cordeiro  
Luan Sidônio Gomes  
Antonio Sérgio Silva de Carvalho

**DOI 10.22533/at.ed.88519231226**

**CAPÍTULO 27 ..... 284**

ULTRASOUND EXTRACTION AND FATTY ACID PROFILE OF GRAPE SEED OIL

Rosana Oliveira Ehlers  
Helena Brito Machado (in memmoriám)  
Jênifer Inês Engelmann  
Marcilio Machado Morais  
Valéria Terra Crexi

|                                    |            |
|------------------------------------|------------|
| <b>SOBRE OS ORGANIZADORES.....</b> | <b>296</b> |
| <b>ÍNDICE REMISSIVO .....</b>      | <b>297</b> |

## ULTRASOUND EXTRACTION AND FATTY ACID PROFILE OF GRAPE SEED OIL

Data de aceite: 11/12/2018

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**ABSTRACT:** This study aimed to extract grape seed oil by ultrasound extraction using the experimental design methodology and determine the fatty acid profile of the oils of Cabernet Sauvignon and Cabernet Franc grape varieties. In the ultrasound extraction, the study

variables were temperature and solvent: sample ratio, and oil yield was the response variable. The working region chosen for ultrasound extraction was under the temperature conditions of around 40 °C and solvent: sample ratio of around 10:1. The oil yield of the Cabernet Sauvignon and Cabernet Franc seeds was 15.2% and 13%, respectively, while the ultrasound extraction efficiency was higher than 92%. The oils of the Cabernet Sauvignon and Cabernet Franc varieties had iodine index values (134.7 cg I<sub>2</sub>/g and 136 cg I<sub>2</sub>/g) and refraction (1.475 and 1.477) and free acidity (0.852 and 0.760% oleic acid), respectively. The sum of unsaturated fatty acids of the oils obtained ranged between 81-84%. The ultrasound method can be used as an alternative to the reuse of winery residues from the grape seed oil extraction. The oil obtained had a good nutritional quality due to its high content of unsaturated fatty acids, thus allowing its use in pharmaceutical and food industries.

**KEYWORDS:** linoleic fatty acid, oleic fatty acid, *Vitis vinifera*

### EXTRAÇÃO VIA ULTRASSOM E PERFIL DE ÁCIDOS GRAXOS DE ÓLEO SEMENTE DE UVA

**RESUMO:** Este estudo teve como objetivo

extrair o óleo da semente de uva via extração por ultrassom utilizando como metodologia um planejamento experimental e determinar o perfil de ácidos graxos dos óleos obtidos a partir das sementes das variedades Cabernet Sauvignon e Cabernet Franc. Na extração por ultrassom, as variáveis de estudo foram temperatura e razão solvente: amostra e como variável resposta o rendimento de óleo obtido. A região de trabalho escolhida para extração por ultrassom foi sob condições de temperatura de 40 ° C e a razão solvente: amostra de 10: 1. O rendimento de óleo das sementes de Cabernet Sauvignon e Cabernet Franc foi de 15,2% e 13%, respectivamente, enquanto a eficiência de extração por ultrassom foram superiores a 92%. Os óleos das variedades Cabernet Sauvignon e Cabernet Franc apresentaram valores de índice de iodo (134,7 cg I<sub>2</sub> / ge 136 cg I<sub>2</sub> / g) e refração (1,475 e 1,477) e acidez livre (0,852 e 0,760% de ácido oleico), respectivamente. O conte de ácidos graxos insaturados dos óleos obtidos variou entre 81-84%. O método de ultrassom pode ser usado como uma alternativa para a reutilização dos resíduos vinícolas na extração de óleo a partir de sementes de uva. O óleo obtido apresentou boa qualidade nutricional devido ao seu alto teor de ácidos graxos insaturados, permitindo seu uso nas indústrias farmacêuticas e alimentícias.

**PALAVRAS-CHAVE:** ácido graxo linoleico, ácido graxo oleico, *Vitis vinifera*

## 1 | INTRODUCTION

The world production of grapes and wines in 2012 was 67 million tons (FAO, 2013) and 252 million hectoliters (DUBA; FIORI, 2015), respectively. In Brazil, in 2011, grape production presented an increase of 49.55% compared to 2000. The country occupies the 11th place in the world rankings of the area planted with vines, reaching a production of 1.542.070 tons of grapes on about 88.000 hectares (FAO, 2013).

The marc consists of stems (25%), seeds (25%) and shell (50%). In recent decades research has shown numerous possibilities of valuation of these by-products through recovery of oil, phenolic compounds and fiber (DUBA; FIORI, 2015). Grape seeds have 10 to 20% of oil in their composition depending on the variety (HANGANU et al., 2012).

The nutritional quality of this oil is due to its high content of unsaturated fatty acids (about 90%), particularly oleic (C18:1) and linoleic (C18:2), essential for human metabolism (HANGANU et al., 2012; DUBA; FIORI, 2015). According to Shinagawa et al. (2015) the consumption of grape oil is still sluggish in Brazil, but in view of the great increase in wine consumption and consequently the generation of waste, grape oil becomes a value-added food.

Traditional methods for the extraction of oil are pressing (DELI et al., 2011) and

the hot solvent extraction (ADAM et al., 2012). The extraction by pressing, obtains a high quality oil. However, this extraction has the disadvantage of oil retention in the press-cake that causes low extraction yield (DELI et al., 2011; ADAM et al., 2012). In the method via hot solvent, the oil is extracted with apolar solvents at temperatures near the boiling point of the solvent, which may be responsible for the formation of free fatty acids. In this extraction method, hexane is typically used during 20 hours of process (GÓMES et al., 1996; AGOSTINI et al., 2012).

Ultrasound technology is based on sound waves generated from a certain frequency, which cannot be heard by humans (SARI; EKINCI, 2017). The ultrasound by extraction method is an alternative to the usual methods of oil extraction and has been applied in the extraction of organic compounds present in particulate materials (ADAM et al., 2012; SETYANINGSIH et al., 2015).

The extraction by ultrasound is associated with cavitation phenomenon. During the propagation of ultrasonic waves in a liquid, cavitation microbubbles are formed due to local pressure variations; the collapse (implosion) of these microbubbles can generate pressures and relatively high temperatures in micro liquid system, facilitating the destruction of the solid surface that is in contact and consequently providing a more effective contact between the solid matrix and the solvent (ADAM et al., 2012; SETYANINGSIH et al., 2015; TAO et al., 2014). This extraction method has been applied with promising results, presenting the advantages of simplicity of equipment, initial cost savings, and in the extraction of organic compounds, increased performance and decreased processing time (TAO et al., 2014).

Ultrasound extraction method has attracted interest since it has positive points (time and yield) compared to the classical method of pressing and solvent extraction (ADAM et al., 2012; SETYANINGSIH et al., 2015). Accordingly, the objective of this work was to study the extraction by ultrasound process of grape seed oil, using the methodology of experimental design, and determine the profiles of fatty acids of grape seed oils of Cabernet Sauvignon and Cabernet Franc varieties.

## **2 | MATERIAL AND METHODS**

### **2.1 Sample Preparation**

The samples used were grape seeds of Cabernet Sauvignon and Cabernet Franc varieties from marcs provided by a winery from the region of Bagé/RS. The seeds were separated by screening, washed and subjected to a heat treatment for enzymatic inactivation in a circulating air oven (Tecnal TE 394/2, Sao Paulo, Brazil) at 80 °C for 10 min (ROCKENBACH et al., 2010) and stored in amber vials at a temperature below 30 °C. To perform the ultrasound extraction experiments, the

seeds were ground in an analytical mill (IKA A11 Basic Mill, São Paulo, Brazil).

## 2.2 Ultrasound Extraction

The ultrasound extraction was performed with 10 g sample of crushed grape seeds of Cabernet Sauvignon variety placed in direct contact with an organic solvent (hexane) in a polished mouth Erlenmeyer flask which was connected to a condenser. This apparatus was placed in an ultrasonic bath (Unique USC-2800A, São Paulo, Brazil; frequency of 40 kHz and 150 W power) at a determined temperature for 30 minutes. In the end of the extraction, separation of the solid and liquid fractions was carried out by vacuum filtration and evaporation of the solvent on a rotary evaporator (Quimis Q344B2, Sao Paulo, Brazil) obtaining the oil. The amount of solvent: sample ratio and the extraction temperature were studied by a experimental design.

## 2.3 Statistical Methodology

The ultrasound extraction experiments were sorted according to Experimental Planning Matrix Full Factorial  $2^2$  with central point, totaling 5 assays performed in duplicate. The study factors used in the ultrasound extraction were temperature (20, 40 e 60°C) of extraction and the ratio of the solvent: sample masses (1:2; 1:10 and 1:18); the response variable of the experiments was the yield of the extraction process. The values of levels of study factors used were determined from preliminary tests and references (ADAM et al., 2012). The results of the experimental design matrix shown in Table 1 were evaluated statistically by analysis of variance (ANOVA) at the 5% level of significance using statistical software, to obtain the variables that influenced the considered response, as well as the best working region for the ultrasound extraction, which was determined by the response square.

The fatty acid profiles of grape seeds oils of Cabernet Sauvignon and Cabernet Franc varieties were obtained in duplicate and the results presented by mean  $\pm$  average deviation. The profiles of both oils were compared by Tukey's mean difference test (BOX et al., 1978), using a statistical software. The values were considered significant at a significance level of 5% ( $p < 0.05$ ).

## 2.4 Analytical Methodology

The lipid content in grape seeds of the Cabernet Sauvignon and Cabernet Franc varieties was determined by Soxhlet, according to the official method of the Adolfo Lutz Institute (2008). The oil samples obtained by ultrasound method (best condition obtained from the results of the experimental design) were analyzed for free acidity (FFA), Iodine Value (IV) and Refractive Index (RI), according to the Adolfo Lutz Institute official methodology (2008).

The identification and quantification of fatty acids was performed by chromatographic analysis of oils from grape seeds of the Cabernet Sauvignon and Cabernet Franc varieties. For injection in the equipment, the methyl esters were prepared according to the methodology described by Metcalfe & Schimitz (1966). The fatty acid methyl esters were identified by gas chromatography (GC) in a chromatograph (Varian CX-3400, Palo Alto, California, USA) equipped with DB-17 capillary column J & W Scientific (Phenylmethylpolysiloxane 50%). The analysis of fatty acid methyl esters was performed in duplicate by injecting 1.0  $\mu\text{l}$  sample (SPLIT ratio 1:50) in the capillary column (30 m length x 0.25 mm internal diameter with a film of 0.25  $\mu\text{m}$  thick). The chromatograph conditions were: 250  $^{\circ}\text{C}$  injector temperature, temperature of the flame ionization detector 300  $^{\circ}\text{C}$ , carrier gas was helium with a flow of 1.00  $\text{ml min}^{-1}$ , linear velocity of 24  $\text{cm.s}^{-1}$  and initial temperature of the column 100  $^{\circ}\text{C}$ , kept at this temperature for 1 min; thereafter, increasing the temperature 6 $^{\circ}\text{C.min}^{-1}$  to 160  $^{\circ}\text{C}$  and 230  $^{\circ}\text{C}$ . The fatty acid methyl esters were identified by direct comparison of retention times with standard (SUPELCO TM 37, Bellefonte, Palo Alto, USA) and quantified by area normalization.

### 3 | RESULTS AND DISCUSSION

The whole samples had mean diameter of Sauter and porosity of  $2.911 \pm 0.106$  mm and  $0.407 \pm 0.019$ . After the milling process the porosity of the bed was increased by about 23%. The increase in the porosity facilitates the extraction of oil, since there is an increase of the surface area of contact with the solvent, facilitating the transfer of mass in the process.

#### 3.1 Experimental Planning

**Table 2** shows the matrix and the results of the  $2^2$  factorial design with center point for the study of the extraction process of oil from grape seeds by ultrasound.

| Experiments | Temperature | Solvent:Sample (*cod) | $\eta$ (%)       |
|-------------|-------------|-----------------------|------------------|
| 1           | 20          | 1:2                   | $8.39 \pm 0.51$  |
| 2           | 60          | 1:2                   | $9.11 \pm 0.78$  |
| 3           | 20          | 1:18                  | $14.08 \pm 0.45$ |
| 4           | 60          | 1:18                  | $15.22 \pm 0.25$ |
| 5           | 40          | 1:10                  | $14.29 \pm 0.42$ |

Table 2: matrix and results of the factorial design  $2^2$  with center point for the extraction of grape seed oil of the Cabernet Sauvignon variety by ultrasound.

Mean value's standard deviation ( $n=2$ ); \* cod = variable level in coded form



Analyzing the results of **Table 2**, it is seen that there was a variation in the process yield from 8% to 15%, which is equivalent to an increase of 80%. Thus, the increased amount of solvent promotes the extraction of oil. This result can be explained by the increase of the process driving force (difference in the oil concentration between the solid matrix and the solvent) in the presence of a greater quantity of solvent, which causes an increase in the mass transfer rates of the matrix (ground grape seed) to the liquid phase (solvent). **Figure 2** shows the Pareto chart of the standardized effects of study variables on the yield of the process.

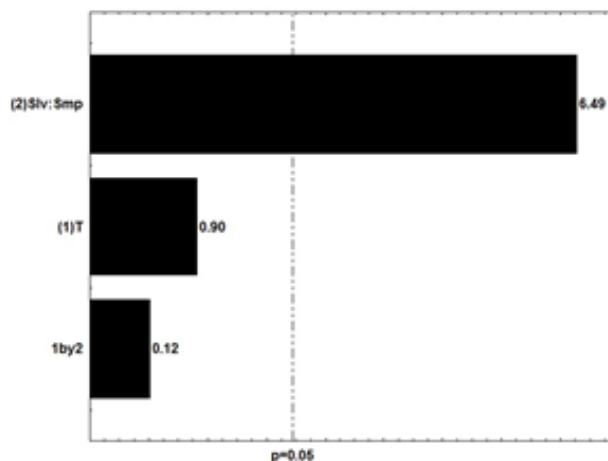


Figure 2: Pareto Chart of the effects of temperature (T) and mass ratio solvent:sample (Slv:Smp) on the response yield of the ultrasound oil extraction process.

Through Pareto chart (**Figure 2**) one can see the effects of the variables that influence the efficiency of oil extraction; it can be seen in this graph that only the solvent: sample ratio was statistically significant ( $p < 0.05$ ) positively affecting the response variable, i.e. the increase in the extraction yield. The variable temperature and its interaction with the variable solvent: sample showed no significant effect ( $p > 0.05$ ).

In your studies Zhang et al. (2009) found too a positive effect of the variable solvent: sample ratio on almond (*Prunus amygdalus*) oil ultrasound extraction efficiency (frequency 40 kHz power 150 W), by increasing the efficiency from 56.1% to 72.3%, varying the solvent: sample ratio from 5:1 to 20:1, respectively. The same behavior was verified by Goula (2013) on the extraction of pomegranate oil by ultrasound, obtaining a larger amount of oil using greater solvent: sample ratios. In the present work it was also found that there was an increase in extraction efficiency from 54% to 98% by varying the solvent: sample ratio from 2:1 to 18:1.

Thus, increasing the solvent: sample ratio (2:1 to 18:1), the oil yield was statistically higher. Higher solvent concentrations in addition to increasing the extraction driving force, promote greater contact with the sample inside its pores,

reducing the mass transfer resistance. Extraction temperatures (20 °C to 60 °C) did not affect significantly ( $p > 0.05$ ) in the yield of the extraction process in the studied zone. This behavior is positive in the extraction, since high temperatures increase the rate of chemical reactions favoring the hydrolysis of triacylglycerol with formation of free fatty acids and also the lipid oxidation reactions.

**Figure 3** shows the response surface of the experimental design, where you can check the best work area to be used for extraction of oil via ultrasound. The effects presented by the study variables are reaffirmed through these response surface were its possible to see that the yield of extraction ranged from 8.89% to 15.73% when the solvent: sample ratio increased from 2:1 to 18:1.

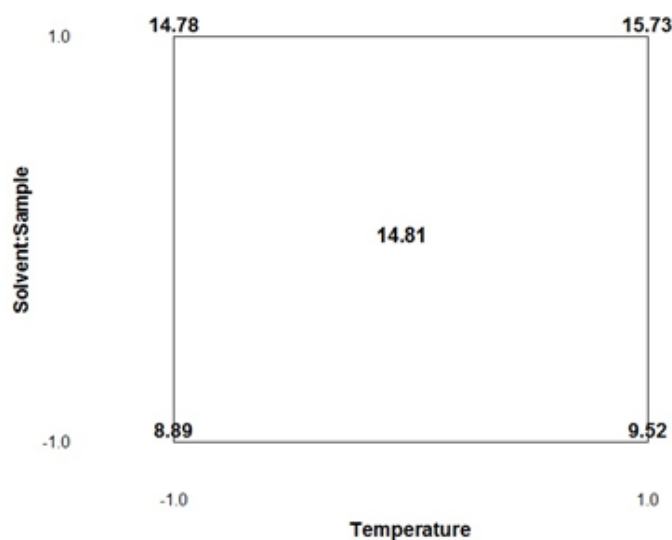


Figure 3: Square response for the oil extraction yield obtained by ultrasound

Through the response surface analysis (**Figure 3**) it is seen that the highest oil content was obtained for the extraction conditions with the highest solvent: sample ratio (18:1), and the center point (10:1). Between levels 10:1 and 18:1, there was a little variability in the efficiency of the oil extraction. This fact may have occurred, possibly due to saturation of the solid matrix by the solvent in the ratio 18:1 at the process time of 30 minutes, not increasing the mass transfer coefficients.

Considering that the best results are based on the higher sample-solvent ratio and that the central point showed a similar behavior, and in terms of lower energy and solvent costs, the central point was choice as the best condition for the process of extraction of grape oil.

### 3.2 Extraction by ultrasound and characterization of oils from the Cabernet Franc and Sauvignon varieties

The oils present in grape seeds from the Cabernet Franc and Cabernet

Sauvignon varieties were obtained in the best ultrasound extraction condition by experimental design (see 2.3), in order to compare the performance and process efficiency, as well as the physicochemical characteristics and profiles of fatty acids of these oils. The Cabernet Sauvignon and Cabernet Franc presented an efficiency of 96.75 and 92.91 % respectively.

The seeds of Cabernet Sauvignon and Cabernet Franc grapes variety showed  $15.73 \pm 1.02\%$  oil content and  $12.70 \pm 0.75\%$ , respectively. These values were within the range mentioned in literature (10 to 20%) (HANGANU et al., 2012). Baydar et al. (2007) extracted by soxhlet the seed oil from four varieties of grapes and obtained oil contents ranging from 12 to 16%. Baydar & Akkurt (2001) investigated the content and quality of grape seed oil of 18 cultivars, obtaining oil quantities from 11.6 to 19.6%. In these studies it can be seen that the variation in oil content depends on the grape variety. Furthermore, it is suggested that there might be a relationship between the oil content in the seed and fruit ripening time (BAYDAR & AKKURT, 2001).

Porto et al. (2013) extracted grape seed oil (Raboso Piave variety) by ultrasound and Soxhlet method, using hexane as the solvent. They obtained an oil content of 14.1% and 14.7% for extraction via ultrasound and via solvent, respectively. One can see that ultrasound extraction efficiency was 96%, similar to that obtained in this work for the Cabernet Sauvignon variety. However, it is worth mentioning that the small differences observed within the same species may be related to the soil, since this directly affects the chemical composition, as a greater proportion of proteins, which interact with oil.

From the results presented and considering that the ultrasound extraction method is performed with less time and lower temperature than the method via solvent (70 °C and 20 hours), according to Gómes et al., (1996) and has higher efficiency than the pressing method, the choice of the ultrasound method becomes more interesting and advantageous. Thus, it is possible to avoid losses in oil quality due to relatively high temperatures and process times; Furthermore, it is possible to increase the extraction efficiency, since oils extracted from the studied varieties showed efficiencies above 92%. The oils from grape seeds of the Cabernet Sauvignon and Cabernet Franc varieties presented iodine index (134 and 136  $\text{cg I}_2 \cdot \text{g}^{-1}$ ) and refractive index according as the values stipulated by ANVISA (National Health Surveillance Agency) for commercial grape seed oils (BRAZIL, 1999) however, the acidity values were above the maximum allowed by law.

The acidity is related to the nature and quality of raw material used, the quality and purity of the lipid, as well as the processing and the storage conditions of the lipid; the free acidity comes from the partial hydrolysis of the triglycerides, a reaction that is catalyzed in the presence of light and heat. Thus, the acidity of the oil present in

the samples used in this work above the maximum allowed, may have occurred due to the raw material being derived from the fermentation of wine processes. Another reason may be related to poor discharge conditions of the samples. Comparing the iodine value of grape seed oil with other oil sources, grape seed oil has a higher degree of unsaturation than rice (99 - 108  $\text{cg I}_2 \cdot \text{g}^{-1}$ ) and canola oils (110 - 126  $\text{cg I}_2 \cdot \text{g}^{-1}$ ), and values in the range of soybean (120 - 143  $\text{cg I}_2 \cdot \text{g}^{-1}$ ) and sunflower oils (110 - 143  $\text{cg I}_2 \cdot \text{g}^{-1}$ ) (BRAZIL, 1999).

### 3.3 Fatty Acid Profiles of oils

The fatty acid profiles of grape seed oils of the Cabernet Sauvignon and Cabernet Franc varieties, are presented in **Table 5**.

| Fatty acid       | Cabernet Sauvignon*       | Cabernet Franc*           |
|------------------|---------------------------|---------------------------|
| C16:0 (palmitic) | 6.80 ± 0.01 <sup>a</sup>  | 6.15 ± 0.01 <sup>b</sup>  |
| C18:0 (stearic)  | 4.50 ± 0.01 <sup>a</sup>  | 3.55 ± 0.02 <sup>b</sup>  |
| C18:1 (oleic)    | 13.10 ± 0.01 <sup>a</sup> | 14.75 ± 0.01 <sup>b</sup> |
| C18:2 (linoleic) | 70.13 ± 0.02 <sup>a</sup> | 69.36 ± 0.01 <sup>b</sup> |
| Σni              | 5.47 ± 0.01 <sup>a</sup>  | 6.19 ± 0.02 <sup>b</sup>  |
| ΣSFA             | 16.30 ± 0.02 <sup>a</sup> | 9.70 ± 0.01 <sup>b</sup>  |
| ΣMFA             | 13.10 ± 0.01 <sup>a</sup> | 14.75 ± 0.01 <sup>b</sup> |
| ΣDFA             | 70.13 ± 0.02 <sup>a</sup> | 69.36 ± 0.01 <sup>c</sup> |
| ΣUFA             | 83.23 ± 0.02 <sup>a</sup> | 84.11 ± 0.02 <sup>b</sup> |
| ΣUFA/ ΣSFA       | 5.35 <sup>a</sup>         | 4.70 <sup>b</sup>         |

Table 5: Fatty acid profiles and lipids class of grape seed oil of the Cabernet Sauvignon and Cabernet Franc varieties.

\* mean value ± standard error (n = 3 triplicate) Σni = unidentified sum.

\* mean value ± standard error (n = 3 triplicate) ΣMFA = sum of monounsaturated fatty acids, ΣDFA = sum of di-unsaturated fatty acids. ΣUFA = sum of unsaturated fatty acids.

In **Table 5**, it is seen that Cabernet Sauvignon and Cabernet Franc oils presented in greater quantity and significantly different the palmitic (C16:0), stearic (C18:0), oleic (C18:1) and linoleic (C18:2) fatty acids. These percentages of fatty acids are similar to those cited by the National Health Surveillance Agency (BRAZIL, 1999) for palmitic (5.5 to 11%), oleic (12 to 28%) and linoleic (58 to 78%) acids. It is worth mentioning that the differences in the fatty acid profiles may be related to genetic factors (FERNANDES et al., 2013), since the samples are of different varieties and these were harvested at the same time and grown under similar environmental conditions.

Researching the yield and composition of grape seed oils by supercritical extraction means for Cabernet Sauvignon and Cabernet Franc, Beveridge et al. (2005) obtained similar results of stearic (4.92%) and oleic (12.71%) fatty acids for

Cabernet Sauvignon. The content of polyunsaturated fatty acids (72.57%) was higher than that found in the present study. For the Cabernet Franc variety, the authors found stearic fatty acid (5.22%) in greater quantities, oleic fatty acid (13.02%) was smaller and linoleic fatty acid (70.28%) was similar with that in this work.

Regarding the class of lipids, it is apparent that the sum of unsaturated fatty acids ranged from 83.23 to 84.11%. The degree of unsaturation is relatively high, though, lower than that presented by Passos et al. (2010), which was approximately 90%, and greater than that cited by Rockenbach et al. (2010). The latter authors investigated the fatty acid composition of grape seed oil and obtained values ranging from 70.4% to 77.1%. The oils extracted in this study have a high proportion of unsaturated fatty acids, presenting high relevance, since they are recommended for human consumption. As for the  $\Sigma$ UFA/ $\Sigma$ SFA ratio, this was 5.35 for Cabernet Sauvignon and 4.70 for Cabernet Franc varieties. Diets in which the  $\Sigma$ UFA/ $\Sigma$ SFA ratio is greater than 0.45 (Department of health and social security –DHSS, 1984) are considered nutritionally healthy.

#### 4 | CONCLUSION

In the study of ultrasound extraction, it was verified that the temperature does not affect the yield of the process; on the other hand, the solvent:sample ratio had significant influence in the response ( $p < 0.05$ ), where larger amounts of solvent gave the highest yield. The values of oil yield ranged from 8.9% to 15.7%. Considering less solvent used and decrease in the process temperature, the central point was choice as the best condition for the process of extraction of grape oil.

The Cabernet Sauvignon and Cabernet Franc varieties showed an oil yield of 15.2% and 13%, respectively. The efficiency of the ultrasound extraction method was superior to 92% for both varieties. Thus, the ultrasound extraction is advantageous due to lower temperature and shorter extraction time in relation to the solvent method and also in relation to pressing, due to a higher extraction efficiency.

The sum of unsaturated fatty acids of the varieties studied ranged from 83 to 84%. Thus, based on the results of the present study, the reuse of wineries waste for extraction of grape seed oil is a good alternative to adding value to the waste, since the oils obtained have a high content of unsaturated fatty acids, especially linoleic acid, an essential fatty acid beneficial to health.

#### REFERENCES

ADAM, F., ABERT-VIAN, M., PELTIER, G., CHEMAT, F. **“Solvent-free” ultrasound-assisted extraction of lipids from fresh microalgae cells: A green, clean and scalable process.** *Bioresource Technology*, v. 114, p. 457-465, 2012.

AGOSTINI, F., BERTUSSI, R., A., AGOSTINI, G., SANTOS, A.C.A., ROSSATO, M.; VANDERLINDE, R. **Supercritical Extraction from Vinification Residues: Fatty Acids,  $\alpha$ -Tocopherol and Phenolic Compounds in the Oil Seeds from Different Varieties of Grape.** The Scientific World Journal, p. 1-9, 2012.

Brazil - Ministry of Health. (1999). **Anvisa Approves the Technical Regulation for Identity and Quality Fixation of Vegetable Oils and Fats. Resolution RDC n° 482.**

BAYDAR, N. G., ÖZKAN, G., ÇETIN, E. S. **Characterization of grape seed and pomace oil extracts.** Grasas y Aceites, v. 58, n. 1, p. 29-33, 2007.

BAYDAR, N. G., AKKURT, M. **Oil Content and Oil Quality Properties of Some Grape Seeds.** Turkish Journal of Agriculture and Forestry, v. 25, p. 163-168, 2001.

BEVERIDGE, T. H. J., GIRARD, B., KOPP, T., DROVER, J. C. G. **Yield and Composition of Grape Seed Oils Extracted by Supercritical Carbon Dioxide and Petroleum Ether: Varietal Effects.** Journal of Agricultural and Food Chemistry, v. 53, n.5, p. 1799-1804, 2005.

BOX, G. E. P., HUNTER, W. G., HUNTER, J. S. **Statistics for Experiments: An Introduction to Design Data Analysis and Model Building,** New York, USA: John Wiley & Sons, 1978.

CODEX ALIMENTARIUS COMMISSION – FAO/WHO. **Codex Alimentarius, Fats, Oils and Related Products.** 2. ed. Roma: Secretariat of the Joint FAO/WHO Food Standards Programme, FAO, Roma, 1993. v. 8, 133 p.

DELI, S., FARAH MASTURAH, M., TAJUL ARIS, Y., WAN NADIAH, W. A. **The effects of physical parameters of the screw press oil expeller on oil yield from Nigella sativa L seeds.** International Food Research Journal, v. 18, n.4, p. 1367-137, 2011.

DEPARTMENT OF HEALTH AND SOCIAL SECURITY - DHSS. **Diet and cardiovascular disease.** London: HMSO, 1984 (Report on Health and Social Subjects, 28).

DUBA, K. S., FIORI. L. **Supercritical CO<sub>2</sub> extraction of grape seed oil: Effect of process parameters on the extraction kinetics.** Journal of Supercritical Fluids, v. 98, p. 33-43, 2015.

FERNANDES, L., CASAL, S., CRUZ, R., PEREIRA, J. A., RAMALHOSA, E. **Seed Oils of ten traditional Portuguese grape varieties whit interesting chemical and antioxidants properties.** Food Research International, v. 50, n.1, p. 161-166, 2013.

Food and Agriculture Organization of the United Nations (FAO). (2013). **Food and Agricultural Commodities Production.** Linseed statistics.

GÓMES, A.M., LÓPEZ, C. P., OSSA, E. M. **Recovery of grape seed oil by liquid and supercritical carbon dioxide extraction: a comparison with conventional solvent extraction.** The Chemical Engineering Journal and the Biochemical Engineering Journal, v. 61, n. 3, p. 227–231, 1996.

GOULA, M. A. **Ultrasound-assisted extraction of pomegranate seed oil – Kinetic modeling.** Journal of Food Engineering, v. 117, n. 4, p. 492–498, 2013.

HANGANU, A., TODASCA M. C., CHIRA, N. A., MAGANU, M., ROSCA, S. **The compositional characterization of Romanian grape seed oils using spectroscopic methods.** Food Chemistry, v. 134, n.4, p. 2453–2458, 2012.

INSTITUTE ADOLFO LUTZ. (2008). **Chemical-physical methods for food analysis.** São Paulo. 4º. ed. São Paulo: Institute Adolfo Lutz, p. 1020.

METCALFE, L.D.A.A., SCHIMITZ, J.R. **Rapid preparation of fatty acid esters from lipids for gas liquid chromatography**. Analytical Chemistry, v. 38, n. 3, p. 510-515, 1996.

PASSOS, C. P., SILVA, R. M., SILVA, F. A., COIMBRA, M. A., SILVA, C. M. **Supercritical fluid extraction of grape seed (*Vitis vinifera* L.) oil. Effect of the operating conditions upon oil composition and antioxidant capacity**. Chemical Engineering Journal, v. 160, n. 2, p. 634–640, 2010.

PORTO, C., PORRETTO, E., DECORTI, D. **Comparison of ultrasound-assisted extraction with conventional extraction methods of oil and polyphenols from grape (*Vitis vinifera* L.) seeds**. Ultrasonics Sonochemistry, v. 20, n. 4, p. 1076–1080, 2013.

ROCKENBACH, I. I., RODRIGUES, E., GONZAGA, L. V., FETT, R. **Fatty acid composition of grape (*Vitis vinifera* L. and *Vitis labrusca* L.) seed oil**. Brazilian Journal of Technology, v. 3, p. 23-26, 2010.

SARI, H. A., EKINCI, R. **The effect of ultrasound application and addition of leaves in the malaxation of olive oil extraction on the olive oil yield, oxidative stability and organoleptic quality**. Food Science Technology, v. 37, n.3, p. 493-499, 2017.

SETYANINGSIH, W., DUROS, E., PALMA, M., BARROSO, C. G. **Optimization of the ultrasound-assisted extraction of melatonin from red rice (*Oryza sativa*) grains through a response surface methodology**. Applied Acoustics, v. 103, p. 129-135, 2015.

SHINAGAWA, F. B., SANTANA, F. C., TORRES, L. R. O., MANCINI-FILHO, J. **Grape seed oil: a potential functional food?** Food Science and Technology, v. 35, n. 3, p. 399-406, 2015.

TAO, Y., ZHANG, Z., SUN, D. **Kinetic modeling of ultrasound-assisted extraction of phenolic compounds from grape marc: Influence of acoustic energy density and temperature**. Ultrasonics Sonochemistry, v. 21, n. 4, p. 1461-1469, 2014.

ZHANG, Q-A., ZHANG, Z-Q., YUE, X-F., FAN, X-H., TAO, L., CHEN, S-F. **Response surface optimization of ultrasound-assisted oil extraction from autoclaved almond powder**. Food Chemistry, v. 116, n. 2, p. 513–518, 2009.

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## ÍNDICE REMISSIVO

### A

Administração Pública 1, 2, 3, 12, 13, 259  
Adsorção com a casca de soja 168, 171  
Agricultura 1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 26, 29, 51, 88, 101, 102, 103, 104, 106, 107, 108, 109, 111, 112, 113, 114, 115, 118, 126, 127, 128, 130, 133, 134, 135, 136, 137, 138, 139, 140, 143, 145, 148, 149, 152, 184, 186, 187, 189, 190, 191, 192, 193, 196, 197, 198, 200, 201, 202, 203, 204, 211, 212, 214, 215, 216, 232, 237, 238, 239, 243, 255, 258, 261, 262, 263, 265, 274, 276, 277, 278, 280, 281, 282, 296  
Agricultura familiar 2, 5, 6, 7, 14, 101, 102, 103, 104, 106, 107, 108, 109, 111, 112, 113, 114, 115, 126, 127, 128, 135, 136, 138, 186, 187, 189, 190, 192, 193, 196, 197, 243, 258, 261, 262, 280, 281, 282  
Agricultura orgânica 137, 276, 277, 280, 282  
Agronegócio 1, 16, 255  
Alcoólico 263, 266, 269, 271, 272, 273, 274, 275  
Ambiente na conservação 175  
Amora-preta 62, 63, 64, 65  
Antioxidantes 31, 32, 33, 36, 40, 62, 64, 65, 69  
Aplicação de adjuvantes 20  
Apreensões 252, 257  
Aprendizagem 244, 245, 246, 248, 249, 250, 251  
Aquênios de girassol 79, 82, 85, 87  
Arbequina 20, 21, 22, 23, 24, 25, 26, 27, 28  
Argentina 140, 152, 186, 187, 189, 198, 199, 200, 215, 216  
Artesanos 154, 155, 156, 157, 158  
Atividade antibacteriana 43, 45, 46, 47  
Atividade antioxidante 42, 49, 58, 62, 63, 64, 65, 66, 71, 76  
Aulas práticas 244, 248  
Azeite de oliva 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

### B

Bagaço de maçã 31, 33, 34, 35, 37, 38, 39, 41  
Berry 62, 63  
Brácteas 50, 51, 52, 53, 54  
Buriti 263, 264, 265, 266, 268, 270, 271, 272, 273, 274  
Butiá de Santa Vitória do Palmar 154

### C

Caracterização química 24, 47, 92  
Celíacos 50, 60

Cepas padrão 43, 45  
Cinética da secagem 79, 81  
Cinética de adsorção 168, 169, 171, 172  
Circuitos curtos de comercialização 101  
Composição florística 116, 118, 125  
Compostos bioativos 20, 62, 63, 64, 65, 69  
Compostos fenólicos 31, 33, 36, 38, 52, 56, 57, 59, 62, 63, 64, 66, 69, 72, 73  
Comunidades 107, 124, 142, 155, 214, 230, 232, 240, 277  
Cookies 31, 32, 34, 35, 36, 37, 38, 39, 40, 41, 50, 51, 58, 60, 61  
Corante 168, 169, 170, 171, 172, 173, 174  
Crescimento 38, 47, 93, 94, 95, 98, 160, 161, 162, 167, 180, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 231, 272  
Cultivo 42, 61, 88, 126, 128, 129, 131, 133, 135, 199, 241

## D

Dianópolis 116, 117, 118, 119, 121, 123  
Dimensões econômicas 230, 231

## E

Embalagem 175, 176, 177, 178, 179, 180, 181, 182, 183, 184  
Estratégias 4, 16, 17, 115, 118, 187, 230, 231, 232, 241, 256, 259, 281  
Estrutura diamétrica 117, 118, 124, 125  
Expansão 31, 36, 38, 39, 162, 230, 234, 235, 236, 274  
Extensión 139, 186, 188, 189, 190, 193, 194, 195, 196, 198, 213  
Extratos bruto 67  
Extrato vegetal 68

## F

Fatty acid 284, 287, 288, 292, 293, 295  
Fécula de mandioca 42, 50, 52, 55, 58, 59, 60  
Feira agroecológica 276, 281  
Fermentação 91, 93, 94, 95, 96, 99, 263, 264, 265, 266, 268, 270, 271, 272, 273  
Fermentado alcoólico 263, 266, 273, 274, 275  
Fibras 25, 31, 32, 33, 34, 36, 37, 38, 40, 51, 52, 95, 98, 155, 264, 265  
Filocrono 160, 161, 162, 163, 164, 165, 166, 167  
Fiscalização de alimentos 252, 254, 256, 259  
Fitoquímica 67, 70, 77  
Fitoquímicos 65, 67, 68, 69, 71, 75  
Fitossociologia 117, 124, 125  
Fragmento de cerrado 116, 119  
Fruta tropical 176, 177  
Fruteira exótica 176

## G

Grape seed 284, 286, 288, 289, 291, 292, 293, 294, 295

## H

*Helianthus annuus* L. 79, 80, 88

*Hylocereus polyrhizus* 67, 68, 69, 76, 77, 78

## I

Inventário Florestal 218, 224

## M

Malaxagem 20, 21, 22, 23, 25, 26, 27, 28

Matriz Swot 16

*Mauritia flexuosa* L. F. 263, 265

Mercado local 101, 135, 212

Método de distribuição 16

Metodologias ativas de ensino 244, 246, 247, 248, 249, 250

Metodologias de ensino 244, 245, 246

Microrganismos multirresistentes 43, 44

Modelagem 83, 86, 88, 89, 218, 219, 220, 223, 224, 225, 227, 228, 229, 296

Modelos de árvore individual 217, 220, 222

Modelos empíricos 218, 220, 221

Monitoria 244, 246, 247, 250, 251

Monogástricos 92

Motivações 126, 127, 130, 133

## N

*Nephelium lappaceum* L. 175, 176, 177, 184

Número de folhas 161, 162, 164, 165

Nutraceutica 62

## O

Organización productiva 154

Otimização 30, 60, 79

## P

Parâmetros físicos 79

Peletização 92, 95, 96

Percepção discente 244, 246

Perfilhamento 161

Perspectivas institucionais 252, 254, 256, 259

Pitaya vermelha 67, 68, 70, 75  
Planejamento Governamental 1, 15  
Planta medicinal 43, 45  
Políticas forestais 198  
Políticas Públicas 1, 2, 3, 4, 5, 6, 7, 10, 12, 13, 14, 15, 127, 148, 158, 196, 198, 232, 233, 252, 259, 261  
Pós-Colheita 25, 79, 80, 81, 82, 88, 175, 176, 177, 180, 184  
Produção agroecológica 126, 128, 130, 133, 134, 135, 137, 138  
Produção florestal 217, 218, 220, 226, 229, 239  
Producción-distribución-consumo 139, 141, 142, 144, 148, 151  
Produtos agropecuários 16, 252, 254  
Produtos de Origem Animal 252, 255, 257, 258

## Q

Qualidade do fruto 25, 176, 177, 182

## R

Ração animal 32, 91  
Rambutanzeira 175, 176  
Recursos orçamentários 1, 2, 12  
Região amazônica 276  
Relações Ambientais 276  
Rendimento 20, 21, 22, 24, 25, 26, 27, 28, 80, 102, 160, 161, 176, 178, 179, 180, 184, 273, 285  
Resíduos de panificação 91, 92, 96, 97, 98, 99  
Resistência antibacteriana 43  
Ruminantes 92, 98, 99  
Rural 2, 5, 6, 7, 10, 11, 12, 13, 14, 61, 99, 105, 106, 114, 126, 127, 129, 130, 134, 135, 136, 137, 139, 143, 144, 152, 166, 167, 175, 186, 188, 189, 193, 194, 195, 196, 212, 216, 230, 231, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 252, 255, 260, 261, 282  
Ruralidade 230, 231, 232, 233, 234, 237, 241, 243

## S

Saberes 186, 190, 191, 192, 196, 238, 240, 260, 261, 276, 277, 278, 279, 281, 282  
Saberes ambientais 276, 277, 278, 281, 282  
Santa Maria 61, 160, 166, 167, 252, 253, 254, 255, 256, 257, 259, 260, 262  
São Vicente do Sul 160, 161, 163  
Savana 117, 118  
Sem glúten 50, 58, 59, 61  
Sensu stricto 116, 117, 118, 120, 121, 122, 123, 124, 125  
Setor têxtil 168, 169  
Sistemas expertos 186, 188, 189, 190, 194, 196  
Soma térmica 160, 162, 163, 164, 165, 167

Subproduto 31, 32, 35, 38, 40, 41, 95, 168, 173

Suinocultura 244, 246, 247, 251

Sustentabilidade 7, 126, 128, 133, 134, 136, 138, 230, 231, 234, 240, 243, 280, 282

Swot 16, 17, 18, 19

## T

Tangará da Serra 126, 128, 130, 132, 136, 138

Taxa de secagem 79

Temperatura 23, 36, 43, 45, 79, 81, 82, 83, 84, 85, 86, 87, 88, 90, 95, 161, 162, 163, 164, 166, 167, 168, 169, 170, 171, 172, 173, 175, 176, 178, 179, 180, 181, 182, 183, 218, 257, 263, 267, 269, 272, 285

Território 2, 7, 44, 117, 230, 231, 232, 233, 234, 235, 236, 239, 240, 241, 242, 256

## U

Ultrasound 21, 29, 30, 284, 286, 287, 288, 289, 290, 291, 293, 294, 295

Universidade Estadual do Ceará 67, 244, 246

Urbano 130, 143, 149, 152, 194, 230, 231, 234, 235, 237, 239, 241, 242, 243

## V

Veterinária 29, 41, 43, 49, 91, 244, 246, 251

Vigilância Sanitária 41, 252, 253, 254, 256, 257, 259, 260, 262

Vitis Vinifera 284, 285, 295

