**UNIVERSIDADE FEDERAL DO PARÁ**
**PROGRAMA DE PÓS-GRADUAÇÃO EM BIODIVERSIDADE**
**E BIOTECNOLOGIA DA REDE BIONORTE**

# POTENCIAL DE USO, ETNOCONHECIMENTO E CONSERVAÇÃO DE *Eryngium foetidum* L. (CHICÓRIA- DO- PARÁ)

**THIARA LUANA MAMORÉ RODRIGUES HIROSUE**

**Belém - PA**
**2024**

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Tese de doutorado apresentada ao Curso de Doutorado do Programa de Pós-Graduação em Biodiversidade e Biotecnologia da Rede BIONORTE, na Universidade Federal do Pará e Museu Paraense Emílio Goeldi, como requisito para a obtenção do Título de Doutor em Biodiversidade e Biotecnologia.

Orientadora: Dra. Ely Simone C. Gurgel
Coorientador: Dr. Washington S. Ferreira Junior

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**Quando apanho uma folha seca caída no chão sinto nela a indiscutível lei do ciclo da vida (Meishu-Sama, em 20 de novembro e 1931).**

Hirosue, Thiara Luana Mamoré Rodrigues. **POTENCIAL DE USO, ETNOCONHECIMENTO E CONSERVAÇÃO DE *ERYNGIUM FOETIDUM* L. (CHICÓRIA- DO- PARÁ)** 2024. 98 f. Tese (Doutorado em Biodiversidade e Biotecnologia) – Universidade Federal do Pará, Belém, 2024.

## RESUMO

Nativa da Amazônia, chicória-do-Pará (*Eryngium foetidum* L.) é uma planta condimentar, medicinal, cultivada por agricultores familiares e amplamente apreciada na culinária nortista do Brasil. Esta pesquisa teve por objetivo analisar o potencial de uso, conservação e o manejo tradicional de *E. foetidum* a fim de contribuir para a formação da cadeia produtiva da espécie, considerando o papel sociocultural e econômico para as comunidades de Curuçambá (Ananindeua) e Campo Limpo (Santo Antônio do Tauá), Pará, bem como para os feirantes e consumidores das feiras livres de Belém do Pará. Os dados foram coletados nas comunidades de Campo Limpo e Curuçamba, foram realizadas entrevistas com agricultores, feirantes, consumidores e chefes de cozinha, por meio de formulário semiestruturado, a abordagem foi qualiquantitativa, com análises de estatística descritiva, frequência de palavras, além das análises de regressão e modelos lineares no *software* R, versão 4.2.1. Os resultados foram divididos em três temas: a) *Eryngium foetidum* L. (Apiaceae): usos tradicionais, composição química e atividades farmacológicas – Artigo de revisão; b) Usos e conhecimento tradicional agronômico de *Eryngium foetidum* L. em comunidades agrícolas (Curuçambá e Campo limpo) no estado do Pará – Amazônia – Brasil e c) Uso tradicional e presença de mercado de *Eryngium foetidum* L. nas feiras livres de Belém, Pará. O maior potencial de uso relatado para achicória é como medicinal, principalmente na América Latina, e restritamente citada naliteratura como alimentar e condimentar, com alta atividade antioxidante de valor farmacológico. Além disso, os dados mostram que a chicória é usada na culinária por diversos atores em diferentes esferas, expressando seu valor cultural regional. O gênero como fator sociocultural afetou os usos para fins medicinais e alimentícios de *E. foetidum*, ressaltando o importante papel das mulheres para a conservação da agrobiodiversidade nas comunidades estudadas. Quanto às técnicas agronômicas, o adubo utilizado pelas comunidades possui diferentes fontes e, por isso, não há relação dos fatores socioculturais com a utilização de adubo produzido na comunidade, conforme as análises estatísticas. Por outro lado, o fator idade indicou tendência à adoção de novas práticas de adubação do solo, sugerindo interesse por parte dos agricultores mais jovens em melhorar o cultivo da chicória. Na esfera comercial, os feirantes mais velhos vendiam *E. foetidum* com base em tradições familiares, e as consumidoras o incorporavam em mais receitas. As folhas da planta eram comumente usadas como tempero alimentar. Assim, este estudo representa um incremento para contribuir com a cadeia produtiva, de uma planta culturalmente relevante para a região Amazônica como a chicória-do-Pará, além de evidenciar diferentes aspectos da importância da sua conservação e uso sustentável frente às ameaças à biodiversidade amazônica.

**Palavras-Chave:** Agricultura familiar; Cultivo, Conhecimento Tradicional; Feiras livres.

HIROSUE, Thiara Luana Mamoré Rodrigues. **POTENCIAL DE USO, ETNOCONHECIMENTO E CONSERVAÇÃO DE *ERYNGIUM FOETIDUM* L. (CHICÓRIA- DO- PARÁ)**2024. 98 f. (Doctoratein Biodiversity and Biotecnology) –Federal University of Pará, Belém, PA-Brazil, 2024.

## ABSTRACT

Native to the Amazon, spiny coriander (*Eryngium foetidum* L.) is a condiment and medicinal plant cultivated by family farmers and widely appreciated in the cuisine of northern Brazil. This research aimed to analyze the potential use, conservation, and traditional management of *E. foetidum* to contribute to the formation of the species production chain, considering the sociocultural and economic role for the communities of Curuçambá (Ananindeua) and Campo Limpo (Santo Antônio do Tauá), Pará, as well as for the traders and consumers of the street markets of Belém do Pará. Data were collected in the communities of Campo Limpo and Curuçambá through interviews with farmers, traders, consumers, and chefs, using a semi-structured questionnaire. The approach was qualitative and quantitative, with descriptive statistics analysis, word frequency, as well as regression and linear models analysis using R software, version 4.2.1. The results were divided into three themes: a) *Eryngium foetidum* L. (Apiaceae): traditional uses, chemical composition, and pharmacological activities – Review article; b) Uses and traditional agronomic knowledge of *Eryngium foetidum* L. in agricultural communities (Curuçambá and Campo Limpo) in the state of Pará – Amazon – Brazil; and c) Traditional use and market presence of *Eryngium foetidum* L. in the street markets of Belém, Pará. The highest reported potential use for spiny coriander is medicinal, mainly in Latin America, and rarely cited in the literature as a food and condiment, with high antioxidant activity of pharmacological value. Additionally, the data show that spiny coriander is used in cuisine by various actors in different spheres, expressing its regional cultural value. Gender as a sociocultural factor affected the medicinal and food uses of *E. foetidum*, highlighting the important role of women in conserving agrobiodiversity in the studied communities. Regarding agronomic techniques, the fertilizer used by the communities has different sources, and therefore, there is no relationship between sociocultural factors and the use of fertilizer produced in the community, according to the statistical analyses. On the other hand, age indicated a tendency to adopt new soil fertilization practices, suggesting interest from younger farmers in improving spiny coriander cultivation. In the commercial sphere, older traders sold *E. foetidum* based on family traditions, and female consumers incorporated it into more recipes. The plant leaves were commonly used as a food seasoning. Thus, this study represents an increment to contribute to the production chain of a culturally relevant plant for the Amazon region, such as spiny coriander, in addition to highlighting different aspects of the importance of its conservation and sustainable use in the face of threats to Amazonian biodiversity.

**Keywords**: Family farming; Cultivation; Traditional Knowledge; Street markets.

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*Eryngium foetidum* L. (APIACEAE): UMA REVISÃO DE LITERATURA SOBRE OS USOS TRADICIONAIS, A COMPOSIÇÃO QUÍMICA E AS ATIVIDADES FARMACOLÓGICAS



CAPÍTULO II

USOS E CONHECIMENTO AGRONÔMICO TRADICIONAL SOBRE *Eryngium foetidum* L. EM COMUNIDADES AGRÍCOLAS (CURUÇAMBÁ E CAMPO LIMPO) DO ESTADO DO PARÁ – AMAZÔNIA – BRASIL



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*Eryngium foetidum* L. (APIACEAE): UMA REVISÃO DE LITERATURA SOBRE OS USOS TRADICIONAIS, A COMPOSIÇÃO QUÍMICA E AS ATIVIDADES FARMACOLÓGICAS



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**SUMÁRIO**

## 1 INTRODUÇÃO

O potencial de uso de espécies nativas e exóticas do Brasil vem estimulando pesquisas voltadas para o uso sustentável e valorização do conhecimento tradicional associado a biodiversidade. Ramos *et al.* (2018) relataram a riqueza da sociobiodiversidade, conceito que ganhou força no Brasil a partir dos anos 2000 na esfera do extrativismo. Nesta década incorporaram-se outras dimensões a respeito da sustentabilidade, destacando a importância econômica, ambiental, social e cultural (DINIZ e CERDAN, 2017).

Para Coradin *et al*. (2022), nos últimos anos foram realizadas pesquisas que consideraram o manejo dos recursos naturais associados à cultura e valoração dos saberes tradicionais, por esta razão, iniciou-se um olhar analítico para a manutenção da biodiversidade, obtendo uma coevolução entre as sociedades e seus ambientes naturais, refletindo em diversos sistemas locais. Desta forma, surgiu o conceito das cadeias produtivas da sociobiodiversidade (CPS), que podem ser definidas como:

> Sistemas constituídos por atores interdependentes e por uma sucessão de processos de educação, pesquisa, manejo, produção, beneficiamento, distribuição, comercialização e consumo de produto e serviços da sociobiodiversidade, com identidade cultural e incorporação de valores e saberes locais e que asseguram a distribuição justa e equitativa dos seus benefícios (BRASIL, 2009).

O panorama das cadeias produtivas da sociobiodiversidade em nosso país é bastante expressivo, por exemplo: no Pampa, com o pinhão (*Araucaria angustifolia* Bertol.) Kuntze (LONGHI *et al*., 2020); na Mata Atlântica, com o açaí-juçara (*Euterpe edulis* Mart.), o butiá (*Butia* spp) e a guabiroba (*Campomanesia xanthocarpa* O. Berg) (PERUCCHI *et al*., 2018; RAMOS, 2019); no Cerrado, com o pequi (*Caryocar brasiliense Camb*.) (OLIVEIRA *et al*., 2019); no Pantanal, com a bocaiúva (*Acrocomia aculeata* (Jacq.) Lodd. ex Mart. (KUFF, 2023); na Caatinga, com o maracujá-da-caatinga (*Passiflora cincinnata* Mast.) (KIILL *et al*., 2019); e na Amazônia, com a castanha-do-Pará (*Bertholletia excelsa* Bonpl.) e o açaí (*Euterpe oleraceae* Mart.) (SILVA *et al*., 2021).

Segundo o estudo Bioeconomia da Sociobiodiversidade no Pará (EcoSocioBio-PA), os produtos da sociobiodiversidade no estado, geraram uma receita de R$ 4,24 bilhões de renda local em 2019 (COSTA *et al.*, 2021). Alguns produtos como o açaí, a borracha, a copaíba e a castanha-do-Pará, têm se destacado no mercado nacional e internacional e possuem suas cadeias produtivas estabelecidas (MAKISHI *et al*., 2020). No entanto, a cadeia de plantas alimentícias não convencionais e medicinais é ainda minimamente estruturada, uma vez que não são plantas produzidas em larga escala (ABREU e JUNQUEIRA, 2023).

Mediante o conhecimento do manejo tradicional e comercialização de espécies nativas, que envolve uma rede interligada de etapas, unindo o valor cultual e econômico, o Plano Nacional de Promoção das Cadeias de Produtos da Sociobiodiversidade (PNPCSB) foi desenvolvido pelo Governo Federal e coordenado pelos Ministérios do Meio Ambiente (MMA), Desenvolvimento Agrário (MDA) e Desenvolvimento Social e Combate à Fome (MDS). Para elaborar planos de ações para a promoção e fortalecimento das cadeias de produtos da sociobiodiversidade, com a agregação de valor cultural e a consolidação de mercados sustentáveis (BRASIL, 2009).

O PNPCSB ao considerar a importância do valor cultural, intrínseco nas cadeias produtivas, desenvolveu os eixos de ações, apontando a importância de pesquisas voltadas para a valoração do saber local, associado aos produtos da sociobiodiversidade. Neste contexto, pesquisas são desenvolvidas para mostrar a influência dos fatores socioculturais e o papel que exercem na compreensão e desenvolvimento nesses sistemas de produção e comercialização (BRASIL, 2009).

Procurando problematizar tal visão, o potencial do uso de plantas medicinais, aromáticas e condimentares da região amazônica, reflete um vasto interesse na produção e comercialização de espécies nativas e plantas alimentícias não convencionais (PANC). Todavia, os manejos destes grupos de plantas, ainda estão baseados no conhecimento tradicional, acarretando uma escassez de estudos que possam delinear essas cadeias (ZACHARIAS *et al*., 2021). Plantas condimentares, conhecidas também como “especiarias” ou “temperos” são cultivadas principalmente por agricultores familiares, vistos como herdeiros e guardiões do conhecimento tradicional, repassados por seus ancestrais, embora, pouco se conheça sobre o perfil sociocultural destes produtores (CORADIN *et al*., 2022).

Ao aprofundar o debate em torno das CPS, uma das formas de avançar no conhecimento é reconhecer a incorporação da identidade cultural material e imaterial. Um dos elementos relevantes para este estudo é a compreensão dos fatores socioculturais, como idade, escolaridade, origem e gênero dos atores que constituem as CPS. Assim, evidenciar o protagonismo dos indivíduos de diferentes perfirs, que somando aos seus ambientes naturais, compõe diferentes sistemas locais de produção, comercialização e usos tradicionais (BASTOS *et al*., 2020; VERANO *et al*., 2021).

Neste cenário, destacou-se *Eryngium foetidum* L., descrita por Carlos Lineu em 1753, cuja obra príncipe foi publicada no *Species Plantarum*, sendo uma espécie aromática condimentar e medicinal (LINNAEUS, 1753; RODRIGUES *et al*., 2019). Nativa da região amazônica, a espécie é cultivada principalmente por agricultores familiares tradicionais, com a finalidade para uso condimentar, em função da ampla apreciação na culinária nortista do Brasil,

empregada em preparações de pratos típicos como o pato no tucupi, a caldeirada de peixe e o tacacá (DORNELES e CHAVES, 2014). O interesse por esta erva deve-se, essencialmente, ao seu agradável sabor e aroma, atribuído ao constituinte volátil eryngial (2-E-dodecenal) contido no óleo essencial produzido, sobretudo, nas folhas (FORBES *et al*., 2013; RODRIGUES *et al*., 2019).

Além da culinária, são constatadas outras aplicações da planta. Paul *et al*. (2011) apontaram propriedades anti-helmíntica, anticonvulsivante e anti-inflamatória. Ademais, podem ser destacadas pesquisas envolvendo os usos tradicionais na medicina popular e farmacológico (ROSERO-GOMÉZ *et al*., 2020; LEITÃO *et al*., 2020; PAUL et *al*., 2011; THOMAS *et al*., 2017; MANJUNATHA *et al*., 2019; BARROS *et al*., 2020). No entanto, são escassos os estudos voltados para hábitos alimentícios e receitas em que a espécie é empregada ou descrita como ingrediente principal.

Ao descreverem o cultivo do coentrão (*Eryngium foetidum* L.) nas áreas produtoras de Cáceres-MT, Da Silva *et al.* (2016) analisaram o perfil dos agricultores familiares e constataram que as idades dos produtores variam de 39 a 92 anos, com predominância da faixa etária de 60 a 69 anos, perfazendo 30% dos entrevistados. Observaram que as pessoas que cultivam *E. foetidum* são mais idosas, sendo 55% dos entrevistados (onze produtores). Desses 55%, 40% são do sexo feminino e apenas 15% do sexo masculino. Com este exemplo, evidencia-se que os perfis dos produtores são de mulheres agricultoras com idade mais elevada.

No estudo de Ranieri e Zanirato (2021) o cultivo das hortaliças e plantas medicinais em quintais urbanos é uma prática incumbida às mulheres, haja vista que o cultivo de alimentos é visto como uma extensão do cozinhar. Além do mais, as mulheres possuem maior conhecimento do que os homens acerca dos usos dos vegetais no que se refere às receitas e preparados com esses alimentos. Outro estudo envolvendo gênero destacou que o conhecimento local de plantas medicinais se encontra bem difundido entre informantes de diferentes classes de idade e gênero (MELO *et al*., 2021). Contudo, as mulheres informaram um total de 142 etnoespécies, sendo 31 exclusivamente citadas por elas, enquanto que os homens mencionaram 96 etnoespécies, com 13 exclusivas a este grupo, apontando, dessa forma, as mulheres como detentoras do conhecimento do uso de plantas medicinais, pois se dedicam ao cuidado com a família, a casa, e ao cultivo de plantas medicinais.

Além do cultivo, outro cenário que compõe as cadeias produtivas, são os mercados e feiras livres locais. Na pesquisa de Silva *et al*. (2021) realizada na feira do município de Assú-RN, os autores analisaram o perfil dos feirantes e consumidores, constatando que os feirantes são do gênero masculino com faixa etária entre 20 a 60 anos, em relação aos consumidores a maioria é do gênero feminino, com faixa etária entre 30 e 40 anos, e a acessibilidade de preço

apresentou-se como a principal motivação para ir à feira, seguida da tradição familiar. Por outro aspecto, Souza *et al*. (2020) observaram na feira livre de Rio Largo (AL) que a média de idade entre feirantes é de 50,8% anos, dos quais 58% são do sexo feminino, com idade entre 31 a 45 anos, enquanto 42% do sexo masculino e entre 46 a 60 anos. Neste sentindo evidenciam-se os diferentes arranjos socioculturais presentes nas feiras livres.

Investigar e analisar os fatores socioculturais, de produtores, feirantes e consumidores, é primordial para o desenhar da cadeia produtiva de *E. foetidum.* Também são necessários trabalhos que avaliem variáveis, como gênero, idade, escolaridade e origem destes agentes envolvidos na cadeia e como estes influenciam nos aspectos do manejo, comercialização e uso da espécie. Coradin *et al*. (2022) apontam *E. foetidum* como uma das plantas para o futuro, entre as espécies nativas da região norte.

Esta pesquisa contribuirá para a descrição da cadeia produtiva de *E. foetidum*, considerando o potencial de uso da espécie, constituído o primeiro relato na literatura sobre análise dos fatores socioculturais dos agentes que participam da cadeia e como suas escolhas podem interferir no engajamento comercial de espécies alimentícias. Bem como identificar gargalos no cultivo e analisar as formas de usos voltados para a culinária, consequentemente, ampliando o conhecimento de usos para a alimentação. Os resultados da pesquisa serão descritos e discutidos nos capítulos seguintes e divididos em três artigos.

No primeiro capítulo, a literatura científica (nacional e internacional) publicada entre os anos de 2011 e 2021 foi revisada sobre os aspectos relacionados aos usos tradicionais, perfil químico e aplicações farmacológicas da chicória-do-Pará, bem como seu papel na alimentação como uso tradicional, a fim de contribuir para o patrimônio cultural gastronômico (RODRIGUES *et al*., 2022). No segundo capítulo, foram investigados os fatores socioculturais dos agricultores familiares, produtores de chicória-do-Pará nas comunidades de Campo Limpo e Curuçambá, localizados respectivamente, nos municípios de Santo Antônio do Tauá e Ananindeua, ambos no estado do Pará, selecionados em função do conhecimento tradicional quanto às técnicas agronômicas de cultivo e usos tradicionais de *E. foetidum*. O terceiro capítulo abordou os usos tradicionais bem como a influência do perfil sociocultural dos feirantes e consumidores de *E. foetidum,* além da descrição dos usos culinários por chefes de cozinha, visando compreender a dinâmica de interação com a cadeia produtiva e seus elos com a cultura alimentar em Belém, Pará, examinando fatores socioculturais e se exercem papel determinante para a comercialização e usos alimentícios.

Assim, o conhecimento sobre os diferentes aspectos socioculturais dos agentes envolvidos na cadeia produtiva da *E. foetidum,* frente à relevância cultural, econômica e conhecimento tradicional associados à planta, contribuirá significativamente com base

científica para a criação de políticas públicas voltadas para o reconhecimento e valorização de espécies nativas e, consequentemente, avançar na valorização da cadeia produtiva, bem como a popularização da espécie na dieta dos paraenses.

## 1.1 OBJETIVO GERAL

Analisar o potencial de uso, conservação e o manejo tradicional de *Eryngium foetidum* L. a fim de contribuir para a formação da cadeia produtiva da espécie, considerando o papel sociocultural e econômico para as comunidades de Curuçambá (Ananindeua) e Campo Limpo (Santo Antônio do Tauá), Pará, bem como para os feirantes e consumidores das feiras livres de Belém do Pará.

## 1.2 OBJETIVOS ESPECÍFICOS

Realizar uma revisão de literatura dos últimos dez anos (2011 – 2021) sobre os usos tradicionais, composição química e aplicações farmacológicas de *Eryngium foetidum* L. (Apiaceae).

Analisar os fatores socioculturais dos agricultores familiares, que influenciam no manejo da planta, bem como avaliar os usos tradicionais de *Eryngium foetidum* L. nas comunidades de Curuçambá e Campo Limpo.

Analisar e discutir os aspectos socioculturais de feirantes e consumidores de *Eryngium foetidum* L., bem como compreender como estes afetam as práticas de comercialização e usos tradicionais desta planta nas feiras livres de Belém do Pará.

Avaliar e relacionar os fatores socioculturais dos feirantes e consumidores a fim de compreender a base da cadeia produtiva de *Eryngium foetidum* L.

# 2 REVISÃO DE LITERATURA

## 2.1 CADEIAS PRODUTIVAS DA SOCIOBIODIVERSIDADE

Partindo do entendimento que em 1992 na Convenção sobre a Diversidade Biológica (CDB), Conferência da ONU sobre Meio Ambiente e Desenvolvimento, realizada no Brasil, foi reconhecida a importância dos conhecimentos e saberes dos povos e comunidades tradicionais. A Convenção está estruturada sobre três bases principais – a conservação da diversidade biológica, o uso sustentável da biodiversidade e a repartição justa e equitativa dos benefícios provenientes (BRASIL, 1998; BRASIL, 2020).

No Brasil, a Política Nacional de Desenvolvimento Sustentável dos Povos e Comunidades Tradicionais foi aprovada pelo Decreto n. 6.040 de 2007 e teve como objetivo a promoção e desenvolvimento sustentável dos povos e comunidades tradicionais, com foco na garantia de seus direitos, sobretudo ao território e a cultura, com respeito e valorização à sua identidade, suas formas de organização e suas instituições (BRASIL, 2007).

No ano de 2007, o Governo Federal criou o Plano Nacional para a Promoção dos Produtos da Sociobiodiversidade (PNPSB), coordenado pelos Ministérios do Meio Ambiente (MMA), do Desenvolvimento Agrário (MDA) e do Desenvolvimento Social e Combate à Fome (MDS), para promover a conservação e o uso sustentável da biodiversidade e garantir alternativas de geração de renda para as comunidades rurais.Por meio do acesso às políticas de crédito, a assistência técnica e extensão rural, a mercados e aos instrumentos de comercialização e à política de garantia de preços mínimos (BRASIL, 2007).

Com o Plano Nacional para a Promoção dos Produtos da Sociobiodiversidade, o governo brasileiro define o termo sociobiodiversidade como a “inter-relação entre a diversidade biológica e a diversidade de sistemas socioculturais” e cadeia produtiva da sociobiodiversidade, ou seja:

> [...] um sistema integrado, constituído por atores interdependentes e por uma sucessão de processos de educação, pesquisa, manejo, produção, beneficiamento, distribuição, comercialização e consumo de produto e serviços da sociobiodiversidade, com identidade cultural e incorporação de valores e saberes locais e que asseguram a distribuição justa e equitativa dos seus benefícios (BRASIL, 2009).

De acordo com o Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio, 2019), entre os principais produtos das cadeias produtivas da sociobiodiversidade no Brasil, encontra-se o açaí (*Euterpe oleracea* Mart. e *Euterpe precatória* Mart.), artesanato, babaçu (*Orbignya* spp. e *Attalea* spp.), borracha (*Hevea brasiliensis* L.), cacau nativo (*Theobroma*

*cacao* L.), castanha-do-Brasil (*Bertholletia excelsa* Humb. & Bonpl.) farinha de mandioca, frutas e polpas, jaborandi (*Pilocarpus microphyllus* Stapf ex Wardleworth), jacaré (*Melanosuchus niger* e *Caiman crocodilus*), madeira de manejo comunitário, óleos vegetais, recursos pesqueiros, pirarucu (*Arapaima* spp.) e turismo de base comunitária.

Esses produtos, entre frutas, castanhas e verduras, constituem as 82 espécies nativas incluídas na Lista de Espécies da Sociobiodiversidade Brasileira (BRASIL, 2019). Na Amazônia, com o PNPSB, os produtos nativos da sociobiodiversidade se apresentam como alternativas sustentáveis para geração de renda de famílias agroextrativistas, ganhando maior repercussão a nível nacional, pois a economia tradicional da Amazônia é configurada pela combinação de produção agrícola para a subsistência e atividades extrativas e pesqueiras (MORAES et al. 2020).

Assim sendo, as Plantas Alimentícias Não Convencionais (PANCs) também são de grande importância para a sociobiodiversidade, pois são utilizadas tanto para a diversificação da alimentação, quanto para agregar alimentos com alto teor de nutrientes a dietas. Todavia, embora essas plantas apresentem algum grau de comercialização e/ou estejam presentes no cotidiano das comunidades urbanas e rurais, elas não possuem cadeia produtiva minimamente estabelecida e a matéria-prima é originada predominantemente do extrativismo (CUNHA et al., 2021; ABREU et a., 2022).

Ademais, a produção de PANCs ainda é limitada por diversos fatores, como a dificuldade em obter sementes e mudas, a falta de integração entre instituições de pesquisa, agricultores familiares e setores de agroindústria, que impedem o aumento da competitividade e a expansão do mercado dessas espécies/variedades (ABREU et al., 2022). Assim, surge a necessidade de estudar espécies nativas de grande potencial nutricional alimentício para a Amazônia, a fim de preencher as lacunas mencionadas e utilizá-las como uma estratégia de conservação, a partir da compreensão de como as suas cadeias de valor surgem, como são estabelecidas e como operam (SILVA *et al.*, 2017).

## 2.2 AGRICULTURA FAMILIAR

A Organização das Nações Unidas para Alimentação e Agricultura (FAO, 2018), define o termo “agricultura familiar”, traduzido para língua portuguesa como um modo de produção agrícola, silvicultura, pesca, pecuária e aquicultura que administra e opera para uma família, depende predominantemente de trabalho familiar, incluindo homens e mulheres. A família ocupa funções econômicas, ambiental, social e cultural (LIMA *et al*., 2019).

No Brasil, a expressão “agricultura familiar” foi consolidada a partir da formalização do Programa Nacional de Fortalecimento da Agricultura Familiar (Pronaf), instituído pela

Resolução nº 2.191/1995, que se destina a dar apoio financeiro às atividades agropecuárias exploradas mediante emprego direto da força de trabalho do produtor e de sua família, para promover o desenvolvimento sustentável no meio rural, melhoria da qualidade de vida e o exercício da cidadania dos agricultores familiares (NAVARRO e MACEDO, 2011).

Nesse sentido, a Lei da Agricultura familiar, lei 11.326 de 2006, considera agricultor familiar e empreendedor familiar rural aquele que pratica atividades no meio rural, atendendo, simultaneamente, aos seguintes requisitos: não detenha, a qualquer título, área maior do que quatro módulos fiscais; utilize predominantemente mão de obra da própria família nas atividades econômicas do estabelecimento ou empreendimento; tenha percentual mínimo da renda familiar originada de atividades econômicas do estabelecimento ou empreendimento, na forma definida pelo Poder Executivo; e dirija o estabelecimento ou empreendimento com a família (BRASIL, 2006).

De acordo com Anuário Estatístico da Agricultura Familiar (CONTAG, 2023), as propriedades de agricultura familiar somam 3,9 milhões no país, representando 77% de todos os estabelecimentos agrícolas. Essas propriedades são responsáveis por 23% do valor bruto da produção agropecuária do país e por 67% das ocupações no campo. São 10,1 milhões de trabalhadores na atividade. O total da produção familiar a coloca como a oitava maior produtora de alimentos do mundo.

A agricultura familiar é de suma importância socioeconômica para o país, pois segundo a Confederação Nacional dos Trabalhadores e Trabalhadoras Rurais Familiares (CONTAG, 2023), a agricultura familiar brasileira é a principal responsável pelo abastecimento do mercado interno com alimentos saudáveis e sustentáveis. Buscando a preservação dos recursos ambientais, a cultura rural, gera ocupações rurais e promove o desenvolvimento sustentável do país.

Desse modo, as práticas da agricultura familiar têm sido consideradas como uma das melhores formas de uso e ocupação dos solos agrícolas, pois além da geração de emprego e renda, os cuidados com a biodiversidade, solos e rios são maiores. Somado a isso, muitas das estratégias de novas cadeias produtivas da sociobiodiversidade surgem do conhecimento tradicional através de experiências reais dessas populações (DIAS *et al*., 2014; OLIVEIRA JÚNIOR *et al*., 2018).

## 2.3 *Eryngium foetidum* L. E USOS TRADICIONAIS

*Eryngium foetidum* L. pertence à família Apiaceae Lindl., gênero *Eryngium* L., é uma erva conhecida popularmente como chicória-do-Pará, chicória-da-Amazônia, chicória-do-caboclo, coentrão, com distribuição na região norte do Brasil, nos estados do Pará, Amazonas,

Acre, Rondônia, Roraima e Amapá (RODRIGUES *et al.*, 2022; FLORA DO BRASIL, 2023). É utilizada principalmente como condimento na culinária devido seu aroma peculiar e como fitoterápico na medicina tradicional (SILVA e LUCAS, 2019; SILVA *et al.*, 2020).

De acordo com a Flora do Brasil (2023), a espécie é classificada como uma erva bianual, ereta, delgada, possui entre 10–50 cm de altura, suas folhas são basais, pecioladas, às vezes pecíolos são obsoletos, oblanceoladas a elípticas, obtusas, com margens serrado–dentadas, dentes mucronados; nervação peninérvea, reticulada nas margens. Seu caule é florífero, ereto, cilíndrico; desnudo ou com folhas caulinas, proximais iguais as basais e alternas, distais sésseis e opostas, serrado–dentadas a fortemente incisas; cimeira foliosa, ramificada, capítulos em monocásios e/ou dicásios.

Os capítulos dessa planta são verdes ou branco–esverdeados, cinzas na frutificação, cilíndricos a oblongos, e exalam forte cheiro de coentro, são sésseis a curto-pedunculados; as brácteas involucrais, foliáceas, estreitamente elípticas a lanceoladas, apiculadas, dentadas com 1–2 pares de dentes a fortemente incisas, patentes a ascendentes, proeminentes muito maiores que os capítulos; as brácteas florais são lanceoladas, maiores que os frutos, distais às vezes subuladas e proeminentes formando coma. Os seus frutos são indeiscentes, densamente papilados, brancos, globosos a ovoides; os mericarpos medem aproximadamente 1,5–2,5 × 1,5 mm, com dorso coberto por papilas globosas, diminutas, isomórficas e possui ventre cilíndrico a oblongo, alargado no ápice (FLORA DO BRASIL, 2023).

Esta planta é rica em óleos essenciais, sendo estes marcados por aldeídos aromáticos e alifáticos; o (2E)-2-dodecenal, conhecido como eryngial, é o principal constituinte químico nas folhas, responsável pelo odor característico da espécie, 13-tetra decenal, trans-2-tetradecenal, 2,3,4-trimetilbenzaldeído, 2,4,5-trimetilbenzaldeído, dodecanal, 1, trimetilbenzaldeído, , τ-cadinol, e α-cadino. Já nas raízes, 2,3,4-trimetilbenzaldeído é o principal constituinte químico, também possui compostos fixos como carotenóides, flavonóides e fenóis (CHANDRIKA *et al*., 2015; THOMAS *et al*., 2017; RODRIGUES *et al*., 2019; RODRIGUES *et al*., 2022).

Entre os usos tradicionais de *Eryngium foetidum*, esta planta é empregada no preparo de peixes, cozidos, carnes, feijão, arroz e na confecção de comidas típicas da região norte como pato no tucupi (prato muito apreciado na ocasião do Círio de Nazaré), tacacá, tucupi, vatapá (DORNELES e CHAVES, 2014; FERNANDES, 2020).

É utilizada pelas comunidades tradicionais como fitoterápico devido suas propriedades farmacológicas, com maior ênfase nas atividades antibacteriana, antioxidante, antifúngica e anti-inflamatória (MEKHORA *et al*., 2012; SINGH *et al*., 2013; LINGARAJU *et al*., 2016). As folhas são as partes da planta mais utilizadas para o preparo de chá e infusões, para tosse, problemas respiratórios, inflamações, dores intestinais, doenças do trato genital feminino

(FLOR e BARBOSA, 2015; SILVA *et al*., 2020; ROSERO-GÓMEZ *et al*., 2020).

*Eryngium foetidum* é uma espécie cultivada majoritariamente pela agricultura familiar, a pleno sol, em quintais próximos à cozinha, em hortas e em áreas que ocorre alagamento, são geralmente plantadas em jiraus suspensos, protegidos das inundações em período de cheia. Seu semeio é realizado a lanço, sendo comum sua dispersão espontânea nos quintais, também ocorre a troca de mudas entre os moradores A adubação utilizada é orgânica, como esterco de animais, galinha e gado, habitualmente (SILVA *et al*.; 2016; SILVA e LUCAS, 2019).

Haja vista o valor nutracêutico e socioeconômico de *Eryngium foetidum,* faz-se necessário a formação da cadeia produtiva dessa espécie, uma vez que fomentar a promoção dos produtos da sociobiodiversidade por meio de políticas públicas voltadas para o atendimento das populações tradicionais, colabora para a conservação e a recuperação ambiental, além de promover qualidade de vida dessas populações (FREITAS *et al*., 2021).

**3** *Eryngium foetidum* **L. (Apiaceae): A Literature Review of Traditional Uses, Chemical Composition, and Pharmacological Activities**

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*Review Article*

# *Eryngium foetidum* L. (Apiaceae): A Literature Review of Traditional Uses, Chemical Composition, and Pharmacological Activities

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*Eryngium foetidum* L. is popularly known as *chico´ria-do-Para´*, is native to the Amazon region, and is widely distributed in Northern Brazil. It is considered a versatile species due to its diversified uses in ethnomedicine, gastronomy, and pharmaceutical industry. The objective of this study was to review the literature on the traditional uses, chemical composition, and pharmacological activities of *E. foetidum* based on information published in national and international scientific articles between the years 2011 and 2021. Literature searches were performed with the combination of the expressions "*Eryngium foetidum* L.," "chico´ria-do-Para´," "traditional uses," "ethnobotany," "volatile compounds," and "essential oil." The species is widely used as a flavoring condiment in beans, meat, duck, and fish, and in the preparation of tucupi (cassava sap), showing to have great importance for the Amazonian food culture. In traditional medicine, it has analgesic, antibacterial, antiflu, and antipyretic applications. The chemical profile is characterized by the presence of aromatic and aliphatic aldehydes, mainly (2E)-2-dodecenal in leaves and 2,3,4-trimethylbenzaldehyde in roots, in addition to fixed compounds such as carotenoids, flavonoids, and phenols. These compounds have shown diverse biological activities and potential antibacterial, anthelmintic, and antioxidant applications, confirming their potential for use in folk medicine. Therefore, it is inferred that this aromatic plant has vast potential uses and is an important alternative as a natural resource for the food and pharmaceutical industries in view of its antioxidant capacity and bioactive compounds.

## 1. Introduction

*Eryngium foetidum* L. (Apiaceae), popularly known in Brazil as *chico´ria-do-Para´*, *coentrão*, *chico´ria-de-caboclo*, *chico´ria- da-Amazo^nia*, and *coentro*, is an unconventional seasoning vegetable and has attracted the interest of researchers due to its wide versatility and growing popularity [1, 2]. One of the important characteristics of the species is the presence of essential oils in its secretory ducts, which are specialized cells present throughout the plant's body rich in bioactive compounds, which add economic value to this plant in international trade and in the perfumery and pharmaceutical industries [3–5].

The peculiar flavor and aroma of *E. foetidum* are due to a chemical constituent present mainly in the essential oil of the leaves, mostly found as an aliphatic aldehyde called eryngial [5, 6]. The leaves are widely appreciated as a condiment and used to season everyday foods such as beans, salads, meat, and fish, as well as in the preparation of typical and tra- ditional recipes such as fish stew, *tacaca´*, *pato no tucupi* (duck stew made with tucupi (indigenous origin; yellowish broth extracted from the roots of wild cassava, boiled and

seasoned with spices such as garlic, chicory, and pepper [7])), and *arroz paraense* (rice with shrimp and other condiments cooked in tucupi) [8, 9].

This species is also used in ethnomedicine, since it has shown potential application in diseases related to the gastrointestinal tract and acts as an antibacterial, analgesic, anti-inflammatory, anthelmintic, anticonvulsant, and anticancer agent, thus proving to have great ethnopharmacological importance for people [10–12]. In this sense, studies have analyzed the applications of *E. foetidum* and have pointed to its pharmacological potential, notably Bhavana et al. [3], Forbes et al. [13], Sumitha et al. [14], and Leitão et al. [15], confirming the bioactive and antioxidant potential of this plant.

For Singh et al. [16], the high medicinal and nutritional value of *E. foetidum* is due to the presence of a range of metabolites such as aldehydes, carotenoids, phenolic compounds, and anthraquinones. However, the knowledge on the potential use of this plant for the population is restricted to traditional communities and people [2, 17].

In this context, this study aimed to review the literature on the traditional uses, chemical profile, and pharmaco- logical activities of *chico´ria-do-Para´* and its role in Amazon's gastronomic cultural heritage based on information col- lected from scientific articles published from 2011 to 2021 to value the potential uses and analyze future prospects of applications of *E. foetidum*.

## 2. Methodology

A bibliographic review of documents published between 2011 and 2021 [18] on the subject was conducted. Literature searches with the following terms in English and Portuguese were carried out: "chicória-do-Para´"; "traditional uses"; "ethnobotany"; "volatile compounds"; and "essential oil" associated with "*Eryngium foetidum* L." and/or "Amazon." Publications from the last ten years were prioritized. The data search tools were as follows: Google Scholar (https://scholar.google.com.br), CAPES Portal (https://www.periodicos.capes.gov.br/), Web of Science (https://www.web.of.sciencegov.br/), and PubMed (https://pubmed.ncbi.nlm.nih.gov/). Only full-length scientific articles and national and international books were considered; monographs, dissertations, and such were excluded.

We favored full-length articles on the topics of taxonomic description, geographic distribution, agronomy, and ethnobotany or ethnobiology that included *E. foetidum* in the list of uses or described the chemical profile and pharmacological applications of the species. The method of categorization of information was adopted for the analysis of scientific productions, grouping key elements to synthesize information, including the dimensions developed in this manuscript [19].

## 3. General Description

### *3.1. Botanical Aspects, Propagation, and Cultural Treatments*

*E. foetidum* belongs to Apiaceae Lindley (Umbelliferae Juss.), a family with approximately 400 genera and 4,000 species, occurring mainly in tropical and subtropical re- gions, with largest distribution in Neotropical regions [20]. In Brazil, 15 genera and 91 species are recognized [21, 22]. According to Boldrini [20], the genus *Eryngium* L. has 250 species distributed in Eurasia, North Africa, North, Central and South America, and Australia. It is composed of herbaceous plants that preferentially colonize terrestrial, rock, and aquatic substrates [21].

The species is popularly known as *chico´ria-do-Para´*, *chico´ria-da-Amazoˆnia*, *coentrão*, and *culantro* [2, 23]. It is widely used as a condiment and in traditional medicine. It is included in the list of species of the Brazilian socio-biodiversity, classified as a rustic tropical vegetable of herbaceous habit, measuring 45 cm in height [22]. The roots are light beige and branched; the stem is straight and cylindrical; and the leaves are basal, spatulate, membranous, glabrous, rosulate, and with a sheath that resembles a channeled petiole. The inflorescences are cymose and can be solitary, paired, formed by a floral axis, with bisexual flowers arranged in small and dense sessile, cylindrical, or ovoid, long-pedunculated capitula. The fruits are globose and scaly [22]. The fruits are indehiscent, densely papillate, white,

1.5–2.5 mm in diameter, and globose to ovoid; mericarps measure ± 1.5–2.5 × 1.5 mm and present tiny, globose, isomorphic papillae on the dorsal face, and cylindrical to oblong ventral face, enlarged at the apex [24]. Figure 1 il- lustrates the morphological structures of the adult plant.

Propagation of the species occurs through the seeds or reuse of clumps, which can be transplanted to the soil [23]. Seeds are obtained from bolting plants planted in the previous months, which are usually chosen and separated for reproduction. Seedlings and botanical material can be acquired through exchanges between local residents, as this plant is autogamous and produces seeds in abundance, typical of the genus *Eryngium*, thus facilitating the reproduction of the species [24].

According to Gomes et al. [23], the sowing of chicory occurs in nursery/seedbeds with a 15 cm plant-to-plant spacing. Fertilization is basically organic, and using broiler litter, [25] recommend the application of biological charcoal associated with organic fertilizer to obtain greater yield of dry and fresh mass of shoots and roots, providing better development to the plant. In the initial stages of plant growth, it is necessary to keep the soil moist through regular watering; after that, it is necessary to irrigate occasionally [26].

Furthermore, it is important to highlight that the management of the species is reported by 100% of the producers of Ca´ceres-MT: as the plant develops, early bolting is seen as an obstacle to the productivity of the species because it paralyzes the growth of the plant, mainly reducing the production of leaves. This happens because the plant directs photoassimilates to the development of flowers and seed production. Thus, the pruning of the floral tassel is suggested to redirect nutrients to the production of the leaves to enhance fresh mass yield [23, 24].

### *3.2. Origin, Occurrence, and Distribution*

*E. foetidum* is native to Central and Latin America and occurs in tropical regions, North and Central America, South Asia, the Pacific Islands, Europe, and Southern Africa

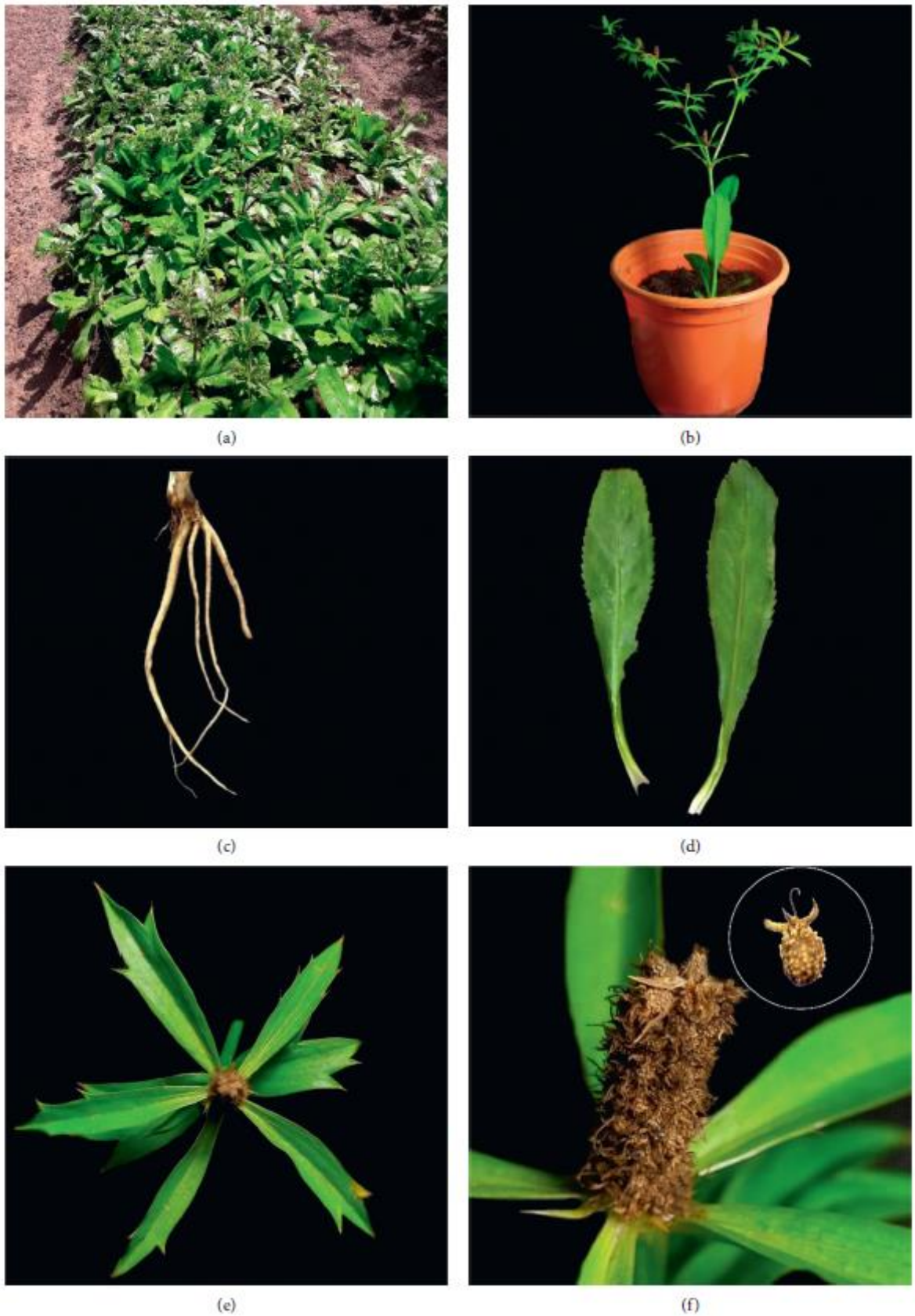


Figure 1: (a) *Eryngium foetidum* L.; (b) in flowerbed; (c) in the vase with leaf and inflorescence; (d) stem and fasciculated root; (e) toothed sheet; (f) bracts, fruit, and seed.

[4]. It is widely distributed in the Brazilian territory, with occurrences in Acre, Amazonas, Amapa´, Para´, Rondônia, and Roraima (Figure 2), with phytogeographic domain in the Amazon [22].

## 4. Traditional Uses

In the last ten years, numerous scientific research articles have cited traditional uses of *E. foetidum*, especially in Latin America and Asia. Twenty-one studies mentioned the use of the species in ethnomedicine in the form of tea to treat inflammation, and nine mentioned it with the application in gastronomy to prepare typical foods.

*4.1. Use in Traditional Medicine.* Historical texts written between the 16th and 17th centuries mention *E. foetidum* as a plant frequently cultivated in the Brazilian territory, known for its medicinal and culinary uses [2, 27]. Previous studies mention chicory as an herb of diverse uses, becoming a material and immaterial good for families belonging to traditional communities. Acosta [28], Montes-Rojas e Paz-Conchas [29], and Gonçalves e Lucas [8] say that *E. foetidum* is a plant used in folk medicine, considering it an excellent way to treat illnesses.

In South American countries such as Peru, Colombia, and Ecuador, the plant is used to treat diseases and ailments related to the digestive and gynecological tract, such as flatulence [2], diarrhea, indigestion, and stomach pain [30, 31]. The tea of the plant is recommended to treat female reproductive problems, promote menstruation, relieve cramps, treat infertility, and facilitate labor, and it is con- sidered to have aphrodisiac action [28, 31, 32]. Scientific productions also highlight the importance of the use of medicinal plants by different peoples and native populations, as they contribute to maintain plant biodiversity, valuing cultural aspects and local identity [2, 33, 34].

For Rosero-Gómez et al. [2], in the San Antonio de Padua community, Ecuador, the forms of traditional uses of the species are passed on from generation to generation, by parents (37%), grandparents (27%), and even spouses (13%) of the residents. They immerse the entire plant (leaves and roots) in hot water to produce tea to treat digestive tract problems such as an imbalance in the in- testinal flora. It is also used in the form of plaster to relieve joint pain, especially in the knees [2]. Traditional knowl- edge of the medicinal use of chicory points to the potential topical use of the species, and Fongod et al. [17] reported the indigenous knowledge about this plant in the South and Southeast region of Cameroon: the leaves are pressed or ground with a little water and used externally to treat abscesses and boils.

Va´squez et al. [35] recorded the use of *E. foetidum* in the form of tea and syrup to fight flu in four riverside com- munities in Amazonas (São Raimundo, Bom Jardim, Nossa Senhora do Livramento, and Rei Davi). The use of the plant to fight flu was also registered in the Quilombola community Taumara-Açu, located in the municipality of Abaetetuba-PA [36]. Fever, cold, sore throat [30, 37], headache [38], and infection [30, 39] are some of the other conditions treated with chicory, mainly in Amazonian communities.

Other important diseases treated with chicory include skin changes, disorders of the nervous and respiratory system [40], hepatitis [41, 42], seizures, malaria, sexual impotence, and kidney problems [31]. It is also reported to be used to alleviate anxiety [37]. In Colombia, the whole plant is used as antiscorbutic, antirheumatic, antiseptic, against vomiting, nausea, headache, and hemorrhage. An- other form of use is in the preparation of baths and in the treatment of smallpox and gonorrhea [31]. In addition, it is used as the ethnomedicine by the traditional people of the form of tea for the treatment of stomach pains [34, 43].

The human experience of the use of *E. foetidum* in ethnomedicine brings together repertoires of local knowl- edge for the cure of diseases and ailments, legitimizing the value of traditional knowledge in communities. Dialogues between memory and tradition configure the transmission of information to descendants, and older women are re- markably the holders of knowledge about the use of the plant [8]. Chicory is recognized as a material and immaterial heritage for agricultural families, communities, and tradi- tional peoples, as it is a natural alternative to help maintain human health.

*4.2. Food Use.* When talking about the food use of chicory, the *Ver-o-Peso* market in Para´ stands out as a representative of the cultural heritage of the state. It is one of the largest open-air markets in Latin America, with points of sale of delicacies from the territory of Para´ that make up one of the largest market places of bio-edible samples in the Amazon [44]. Herbs, spices, and aromas are commercialized, in- cluding some regional herbs, symbols of the local cuisine, for example, *jambu* (*Spilanthes oleracea* L.) and *chico´ria-do- Para´* (*Eryngium foetidum* L.). The latter offers a special flavor and aroma to foods, which comes from its chemical com- ponents, especially (2E)-2-dodecenal, known as eryngial [5, 6].

Plants are used as flavoring in various foods, Vilhena et al. [45], Batista and Barbosa [46], and Barros et al. [47] report that *E. foetidum* is a food condiment. Gonçalves and Lucas [8] present *E. foetidum* as a condiment cultivated in backyards close to the kitchen among the food species used by the traditional peoples of Altamira, Para´, Brazil. It is also considered as a family asset by these people because, in the process of deterritorialization that took place in Belo Monte, river-dwelling families transported plants from their pro- ductive areas to new homes, and chicory was carried in their luggage along with other plants and personal objects, [48]. This fact reveals the interaction and cultural and ethnic aspects as well as the traditional culinary value of the species.

Vilhena et al. [45] mention that in the shopping centers of Bele´m-Para´, typical regional food recipes such as *tacaca´* (indigenous origin; prepared with “tucupi” and cassava starch, served with dried shrimps and “jambu” [44]), *vatapa´* (typical of the Afro-Brazilian cuisine; it is usually prepared with corn starch, milk, salted shrimp, palm oil, coriander, chicory, onion, garlic, green pepper, and tomato [49]),

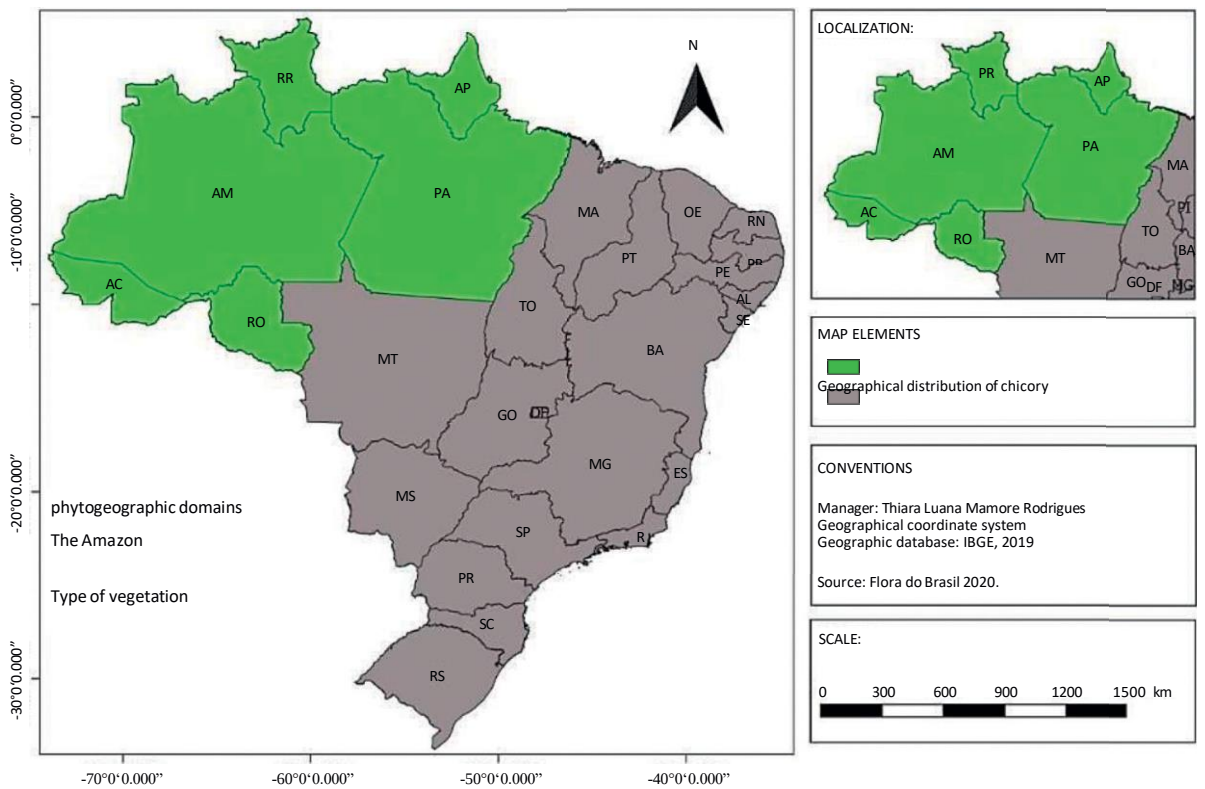


Figure 2: Phytogeographic domains of *E. foetidum* L. in Brazil. Source: adapted from Flora do Brasil [22].

*caruru* (African origin; widely consumed in the northern region of Brazil; it is a stew made from cassava flour, dried shrimp, palm oil, pepper, chicory, coriander, onion, and tomato [49]), and *maniçoba* (indigenous origin; dish whose main ingredient is "maniva," i.e., cassava leaves ground and cooked with pork, salted beef, and sausages; it resembles "feijoada," with cassava leaves in the place of beans [50]) are sold for appreciation of flavors. Due to the influence of the local food culture, *E. foetidum* is used in recipes to add flavor and preserve food. Dorneles and Chaves [51] highlight *E. foetidum* as an indispensable spice in the preparation of *tacaca´*, known as a food of indigenous origin prepared with cassava products such as *tucupi* and starch (derived from a type of indigenous soup called *mani poi*; it is made from the starch that is extracted from the cassava; it is also known as tapioca gum and dry gum [50]), along with salted shrimp and *jambu* leaves (a flowering herb typical of Northern Brazil). It is served hot in a traditional indigenous utensil: the *cuia* (type of gourd), supported by a straw basket. *Pato no tucupi* is mainly consumed in C´ırio de Nazare´, seasoned with salt, garlic, and black pepper, cooked in *tucupi*, with the addition of *E. foetidum*, *jambu*, and basil, and served with white rice, cassava flour, and habanero pepper sauce [52] (typical of the Afro-Brazilian cuisine; it is usually prepared with corn starch, milk, salted shrimp, palm oil, coriander, chicory, onion, garlic, green pepper, and tomato) [49].

Some preparations are mujica [7], *tacaca´* [51] *caruru*, and *caldeirada de peixe no tucupi* [9]. Fish dishes and *moqueca* (saltwater fish stew in coconut milk) [53], and *pato no tucupi* [54] include chicory as a condiment. In Asia, chicory is used in soups, noodle dishes, and curry (spice mix) [6]. There are a greater number of studies from Latin American countries that mention the use of chicory as a condiment for food seasoning [7, 27, 46, 54]. The traditional uses of *E. foetidum* are summarized in Table 1.

## 5. Chemical Profile

In the literature, 22 articles on this theme were found in the different databases surveyed.

*5.1. Volatile, Fixed Compounds, and Minerals.* Some essential oils are products of secondary metabolism, normally produced by aromatic plants. They are defined as complex mixtures and have high added value due to their applications in the pharmaceutical industry [5, 15].

The chemical profile of the essential oils from *E. foetidum* is characterized by aromatic and aliphatic aldehydes. The major constituent, (2E)-2-dodecenal, known as eryngial, was first reported in the literature by Koolhaas in 1932 and is the substance responsible for the peculiar flavor and aroma of the species [57]. Note that the chemical composition of the chicory leaf and root is similar, because Chandrika et al. [58], Thomas et al. [1], and Rodrigues et al. [5] identified (2E)-2-dodecenal in the leaves and roots of *E. foetidum*, in addition to 13-tetradecenal, *trans*-2-tetradecenal, 2,3,4-trimethylbenzaldehyde [5], 2,4,5-trimethylbenzaldehyde, dodecanal [1], 1, trimethylbenzaldehyde, $\tau$-cadinol, and $\alpha$-cadinol [58].

Table 1: Traditional uses of *Eryngium foetidum* L.

| Medicinal | Locality | Popular name | Illness | Plant part used | Form of use | Ref. |
|---|---|---|---|---|---|---|
| | Brazil | Chicória, coentrão | Infection | Leaves | Tea | [39] |
| | | | Flu, diarrhea, and stomach pain | Leaves and roots | Tea/syrup | [35] |
| | | | Teething, flu, diarrhea | Roots | Tea; tea prepared with chicory root and "sacaca" leaves; tea prepared with chicory root and mint roots | [36] |
| | | | Headache | | Maceration | [38] |
| | | | Cough and urinary infection | | — | [55] |
| | | | Used to accelerate labor | Roots | Tea | [33] |
| | | | Used in religious/cultural rites for "quebranto" | Leaves | Tea/bath | [43] |
| | | | Gastrointestinal problems such as flatulence, indigestion, and stomach problems; infections and infestations such as smallpox and worm infestation; respiratory system (flu) | | — | [30] |
| | Colombia | Cilantro sabanero | Hepatitis | Roots | Infusion; boiled and taken three times a day | [41, 42] |
| | | | Malaria, seizures, spasms, sexual impotence, gastrointestinal problems (antiflatulent, stomach pain, vomiting, diarrhea, nausea), flu-like symptoms (headache, cough, flu), cramps, bleeding; antiscorbutic, antirheumatic, antiseptic, and febrifuge | Whole plant | Baths and cooked in food | [31] |
| | Panama | Culantro | Purgative/taenifuge or vermifuge and sedative; used in witchcraft | Leaves | Oral intake at cold temperature; raw | [34] |
| | Peru | Siuca culantro | Cramps, anxiety, sore throat, and weight loss | | — | [37] |
| | Ecuador | Culantro de monte | Labor stimulant, cramps, antidiarrheal, menstrual pain, aphrodisiac, abortifacient, diuretic, and antiemetic | | — | [28, 32] |
| | | | Stomach problems such as dysentery, joint pain, especially in the knee | Leaves and roots | Infusion and plaster | [2] |
| | | | Skin changes, gastrointestinal and respiratory diseases, pathologies, and disorders of the nervous system | Leaves | — | [40] |
| | Cameroon | — | Abscesses and boils | Leaves and stems | The leaves are squeezed or ground with a little water resulting to prepare a solution. External use | [17] |
| | China | — | Cough, dyspepsia (poor digestion), snake bite | — | Decoction, poultice (plaster) | [56] |

| | Locality | Recipes | Ingredients | Ref. |
|---|---|---|---|---|
| Gastronomic | Brazil (Pará) | "Caldeirada paraense no tucupi" (Pará stew with tucupi) | Fish, tucupi, green condiments (chicory, scallion, coriander), jambu, garlic, onion, green pepper, bay leaf, basil, tomato, potato, eggs | [9] |
| | | "Pato no tucupi" (duck stew made with tucupi) | Dry salted shrimp, green condiments (chicory, scallion, coriander), okra, jambu, garlic, onion, palm oil, tomato | [9, 52, 54] |
| | | "Caruru" | Dry salted shrimp, green condiments (chicory, scallion, coriander), okra, jambu, garlic, onion, palm oil, tomato | [9] |
| | | "Tacacá" | Chicory, jambu, tucupi, cassava starch, dried shrimp, garlic, and habanero pepper | [9, 51] |
| | | "Mujica" | Cassava flour porridge mixed with crab or fish meat, cooked with lemon in water, garlic, salt, and margarine, seasoned with chicory, basil, and coriander | [7] |

Chandrika et al. [58], Thomas et al. [1], and Rodrigues et al. [5] analyzed the chemical profile of the vegetative organs of *E. foetidum* in India, Nigeria, and Brazil (Para´), respectively, and reported (2E)-2-dodecenal as the major constituent present in the leaves, while the main elements in the roots were 2,3,4-trimethylbenzaldehyde (Brazil) and 2,4,5-trimethylbenzaldehyde (India and Nigeria). Among the vegetative organs, the moisture of the leaves can vary from 10.33% to 87% according to the methodology used [5, 15, 59]. For the identification of the chemical constituents of chicory, gas chromatography-spectrometry analysis is the most used method [1, 6, 58, 60, 61].

The methods used for extraction of the essential oil from chicory include the hydrodistillation and steam distillation method. Hydrodistillation has been the most used, reported in the works by Jaramillo et al. [60], Ngang et al. [61], Sumitha et al. [14], Chandrika et al. [58], Thomas et al. [1], Rodrigues et al. [5], and Castro-Alayo et al. [62], and steam distillation is used for extraction. With these methods, levels from 2.8% [58] to 7.65% [1] of (2E)-2-dodecenal were found

in the roots and between 14.3% [58] and 50.62% [61] in the leaves. There was also a qualitative difference between the identified compounds: Castro-Alayo et al. [62] cited (Z)-13-octadecenal, $\alpha$-pinene, *m*-cymene, and *o*-cymene components that are not mentioned in other studies as the major compounds.

Among the constituents identified in the essential oil of

*E. foetidum* leaves reported in the works, only three compounds do not differ, namely (2E)-2-dodecenal, the most often cited in the literature, found at percentages varying from 50.62% [61] to a minimum of 14.3% [58]; dodecanal, found at maximum values of 14.59% and minimum values of 4.7% [1]; and Ngang et al. [61] with approximate levels of 11 and 10.77%, respectively. Therefore, there are no qualitative differences between the essential oils of leaves and roots, but there are quantitative differences in terms of percentage. The other major compounds listed in Table 2 appear only once in each study.

In India, 93 compounds were detected in leaf and root samples of *E. foetidum* from two localities (Port Blair and Nadugani). (2E)-2-dodecenal (2.9%), trimethylbenzaldehyde (16.5%), dodecanal (4.7%), and caryophyllene oxide (2.6%) were found in the leaves of the plants from Port Blair. The oil from leaves of the samples from Nadugani was rich in the constituents trimethylbenzaldehyde (14.3%), dodecanal (3.3%), (2E)-2-dodecenal (14.3%), $\tau$-cadinol (5.1%), and $\alpha$-cadinol (6.9%). The main compounds of the oil from the roots of plants from Port Blair were isomeric trimethyl benzaldehyde (57.0%) and dodecanal (2.3%). In turn, the oil from the roots of plants collected in Nadugani had a composition similar to that of the leaves, with the addition of (2E)-2-dodecenal (2.8%), $\tau$-cadinol (7.3%), and $\alpha$-cadinol

(10.2%) as main compounds [58].

Similar data were found in leaf samples of *E. foetidum* in Colombia, which showed a high percentage of aldehydes ((2E)-2-dodecenal, 5-dodecene, tetradecanal, tetradecenal) and aromatics (2,4,6-trimethylbenzaldehide, 3,4,5-trimethylphenol) [60]. The essential oil of leaves of *E. foetidum* has a high antioxidant capacity, being therefore an important source of natural biocompounds [16]. It is noted that essential oils from *E. foetidum* are marked by aromatic and aliphatic aldehydes: (2E)-2-dodecenal in leaves and 2,3,4-trimethylbenzaldehyde in roots. The chemical compounds present in the essential oil of *E. foetidum* are shown in Figure 3.

It can be observed that the chemical composition is variable among species of the genus Eryngium. In *Eryngium bungei* Boiss, the major components found in the hydrodistilled oil were borneol (44.4%), isobornyl formate (14.7%), isoborneol (9.2%), 1,8-cineole (9.1%), and camphor (7.9%) [64]. In *Eryngium caeruleum* Bieb, the oil was mainly composed of limonene (25.42%), cyclobuta[1, 2 : 3, 4]dicyclooctene-hexadecahydro (22.24%), and $\delta$-2-carene (16.19%) [65]. It is important to emphasize that none of these compounds are mentioned as the major compound of *E. foetidum*.

When analyzing the chemical profile of *Eryngium campestre* L. and *Eryngium amethystinum* L., Cianfaglione et al. [66] detected similar compounds, including sesqui- terpene hydrocarbons, with germacrene D, followed by alloaromadendrene, $\beta$-elemene, spathulenol, and ledol. These compounds were not found in *E. foetidum*. However, the chemical composition of species of the genus Eryngium is not restricted to volatile organic compounds and works such as that found by Paun et al. [67], who highlights that *Eryngium planum* L. contains mainly flavonoids, especially rutin, a compound also present in *E. foetidum*, cited by Chandira and Jaykar [68], Singh et al. [16], Lingurajo et al. [12], Campos et al. [69], and Nguyen [70]. However, alka- loids and anthraquinones were also found, and these con- stituents are rarely found in *E. foetidum* [71, 72]. Swargiary et al. found that *E. foetidum* contained high content of carbohydrates ($174.72 \pm 1.72$ $\mu$g/mg) and proteins ($65.58 \pm 5.26$ $\mu$g/mg), in addition to vitamins B12 and C, or ascorbic acid, present at high concentration in the leaves ($14.17 \pm 1.17$ $\mu$g AAE/mg). This vitamin is antioxidant and an important free radical catalyst, justifying the nutritional value of the plant [73–75]. The main constituents of the chemical profile of *E. foetidum* are summarized in Tables 2 and 3.

In addition to organic compounds, other studies have

shown that *E. foetidum* has in its composition the presence of fixed minerals, among others. As found in the study by Singh et al. [59], *E. foetidum* presented high concentrations of crude fiber (maximum of 6.32% and minimum of 0.51%); the protein content ranged between 5.25% and 0.13%, and crude leaf fat ranged between 1.95% and 0.06%. Other minerals such as potassium (K), phosphorus (P), cobalt (Co), manganese (Mn), copper (Cu), sodium (Na), zinc (Zn), calcium (Ca), iron (Fe), vanadium (V), and magne- sium (Mg) were also found.

## 6. Pharmacological Activities

Nineteen studies on the use and pharmacological application of *E. foetidum* were found, with greater emphasis on antibacterial, antioxidant, antifungal, and anti-inflammatory activities.

Table 2: Volatile compounds present in *Eryngium foetidum* L.

| Chemical constituents | Leaf (%) | Root (%) | Ref. |
|---|---|---|---|
| | 21.76 ± 30.4 | 3.75 ± 6.24 | [5] |
| | 28.43 | 7.65 | [1] |
| | 43.96 | — | [60] |
| (2E)-2-Dodecenal | 50.62 | — | [61] |
| | 14.3 | 2.8 | [58] |
| | — | — | [13] |
| | 46.68 | — | [14] |
| 13-Tetradecenal | 27.45 | 9.26 | [1] |
| | 5.41 | — | [60] |
| *Trans*-2-tetradecenal | 8.61 to 13.33 | 2.46 to 3.75 | [5] |
| | 14.59 | 1.0 | [1] |
| Dodecanal | 10.29 | — | [61] |
| | 4.7 | — | [58] |
| 2,4,6-Trimethylbenzaldehyde | 16.5 | 4.00 and 57.0 | |
| | 1.5 and 14.3 | 2.2 and 24.1 | |
| 2,4,5-Trimethylbenzaldehyde | 10.77 | 56.08 | [1] |
| | 11.00 | | [61] |
| 2,3,4-Trimethylbenzaldehyde | 19.5 to 24.6 | 56.81 to 63.49 | [5] |
| 5-Dodecene | 30.15 | — | |
| Tetradecanal | 5.28 | — | [60] |
| 3,4,5-Trimethylphenol | 3.08 | — | |
| 2,4,6-Trimethylbenzaldehyde | 2.24 | — | |
| 1-(2-Methylbutyl)-1-(1-methylpropyl)cyclopropane | 5.94 | — | [61] |
| α-Pineno | 3.49 | — | |
| (*Z*)-13-octadecenal | | — | [62] |
| Muurola 4,10(14)-dien-1α-ol | 10.2 | — | |
| Neophytadiene isomer | 4.5 | — | |
| Hexahydrofarnesyl acetone | 5.5 | — | |
| Neophytadiene isomer | 4.5 | — | |
| Hexahydrofarnesyl acetone | 5.5 | — | [58] |
| Phytol | 4.9 | — | |
| 2-Formyl 1,1,5-trimethyl 2,5-cyclohexadien-4-yl-2-methylbutenoate | — | 4.9 | |
| ?-Cadinol | 5.1 | 7.3 | |
| α-Cadinol | 6.9 | 10.2 | |
| Caprylic alcohol | 14.80 | — | |
| 1,4-Dihydrocarbazole-1,4-dione | 11.29 | — | [14] |
| Lauraldehyde | 10.22 | — | |
| α-Pinene | — | — | |
| M-Cymene | — | — | [62] |
| O-Cymene | — | — | |
| Lasidiol *p*-methoxybenzoate | — | — | [63] |

*6.1. Antibacterial Activity.* In this section, six studies published between the years 2011 and 2021 were found in the databases. India stood out with the majority (four) of the studies on the theme.

*Helicobacter pylori* is a bacterium that affects the stomach. About 50% of people test positive for the presence of this pathogen and 20% develop related gastroduodenal diseases. Mabeku et al. [71] conducted *in vitro* and *in vivo* tests in rats to measure the reduction in the bacterial load of six strains using methanol extracts of *E. foetidum* (500 mg/ kg). The extracts resulted in an abundance of metabolites and antipathogenic properties both *in vitro* and *in vivo*, with efficiency similar to ciprofloxacin. Panda et al. [79] showed the antibacterial effect of this herb through the use of methanolic extracts, acting in the minimum inhibitory concentrations (≥12 mm) against *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli*, *Salmonella typhimurium*, *Shigella sonnei*, *Shigella dysenteriae*, *Shigella flexneri*, and *Vibrio cholerae*.

For Begum et al. [80], the nontoxic and economical biosynthesis technique of ZnO nanoparticles (NPs) used to assess the antibacterial potential of herbs is an ecologically clean and environmentally acceptable technique. The extract of *E. foetidum* leaves was analyzed through this characterization by these authors, and they found that the biosynthesized ZnO NPs were an excellent agent against *E. coli*, *Pseudomonas aeruginosa*, *S. aureus subsp. aureus*, and *Streptococcus pneumoniae* [80]. In addition, the combination of chicory with other popular medicinal plants from Assam, India, presented enhanced antibacterial and antifungal effects [72]. There was a synergistic positive effect of *E. foetidum* + *Bacopa monnieri* against *S. typhimurium*. The medicinal characteristics of these plants may be due to the presence of alkaloids, flavonoids, tannins, steroids, saponins, and phenols [72].

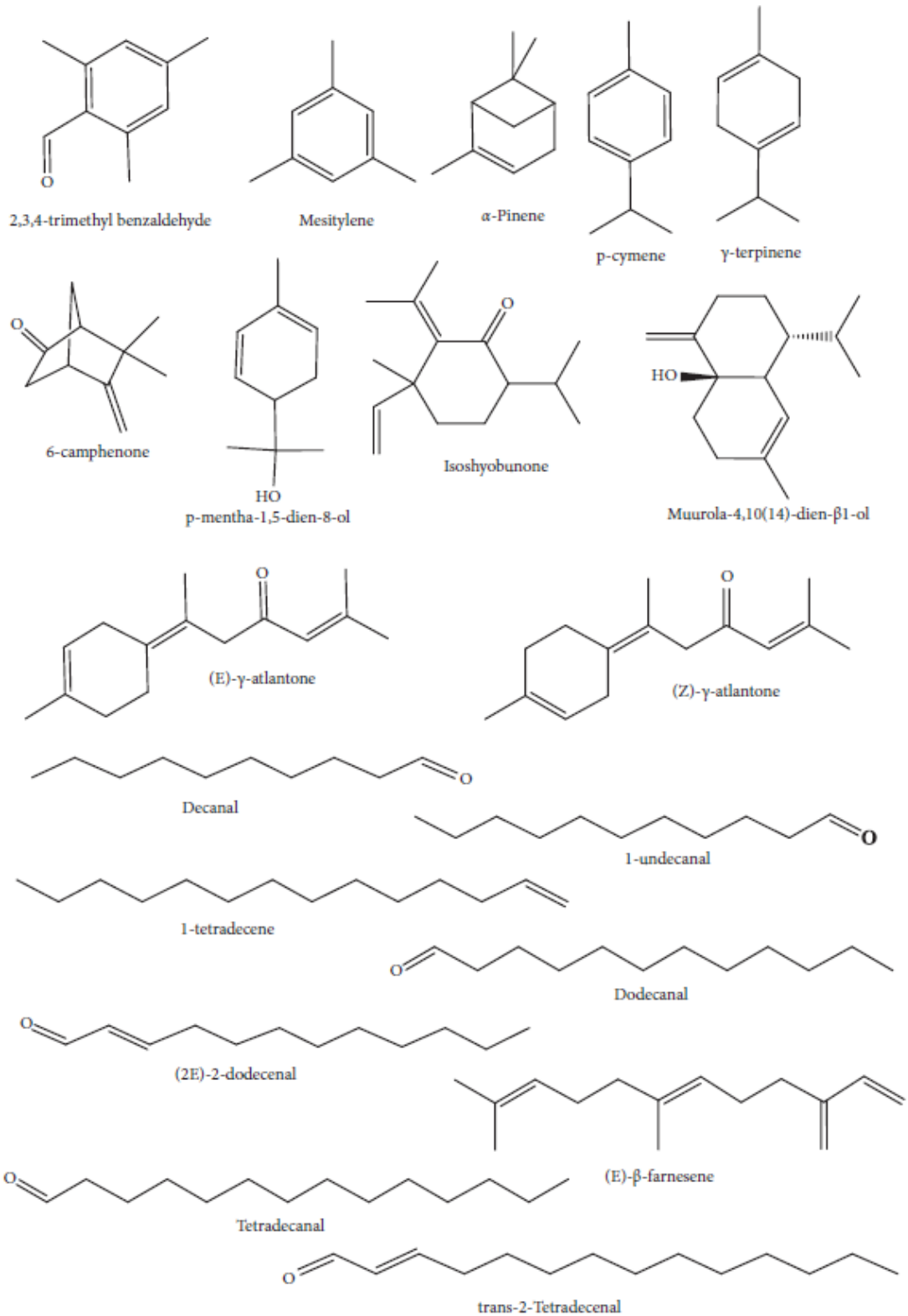


Figure 3: Structures of chemical compounds identified in essential oils of *Eryngium foetidum* L. adapted from Rodrigues et al. [5].

The methods of solvent extraction from leaves have an influence on the quantification of active principles and the assessment of potential activities of plants. For example, Dalukdeniya and Rathnayaka [78] reported that the meth- anol and chloroform extracts had high antibacterial activity against *S. pneumoniae*, *Listeria monocyatogenes*, and *S.*

Table 3: Fixed organic compounds present in *Eryngium foetidum* L.

| Chemical constituents | Leaves | Ref. |
|---|---|---|
| Chlorogenic acid | 4.327 $\mu$g/g | [15] |
| | 338 $\mu$g/g | [76] |
| | 174.72 ± 1.72 $\mu$g/mg | [75] |
| Carbohydrates | — | [68] |
| | 128.0 ± 5.6 mg/g | [69] |
| | 134.0 ± 5.9 mg/g | |
| | $\mu$g/100 g | [59] |
| Carotenoids | 84.3 ± 3.1 $\mu$g/g | [69] |
| | 78.8 ± 5.4 $\mu$g/g | |
| Chlorophyll a | 1.32 ± 0.09 mg/g | [77] |
| | 208.9 ± 12.3 $\mu$g/g | [69] |
| | 199.5 ± 19.5 $\mu$g/g | |
| Chlorophyll b | 0.42 ± 0.03 mg/g | [77] |
| | 101.5 ± 5.3 $\mu$g/g | [69] |
| | 93.4 ± 8.3 $\mu$g/mg | |
| Crude fiber | 6.32 ± 0.5 $\mu$g/mg | [59] |
| Alkaloids | — | [71] |
| | 365.5 $\mu$g/ml | [72] |
| | — | [71] |
| Phenols | 7.8 ± 0.00 mg/g | [78] |
| | 0.07 ± 0.00 mg/g | |
| | 3.72 ±0.02 mg/g | |
| | — | [68] |
| | 164600 $\mu$g/ml | [72] |
| | 40.4 ± 0.8 mg/g | [69] |
| | 40.4 ± 1.0 mg/g | |
| | — | [70] |
| | — | [71] |
| | — | [12] |
| | 1547.9 $\mu$g/ml | [72] |
| Flavonoids | 1.81 ± 0.1 mg/g | [69] |
| | 1.88 ± 0.1 mg/g | |
| | 113.5 ± 180.3 mg/100 g | [16] |
| | — | [68] |
| | — | [70] |
| Anthraquinones | — | [71] |
| Anthocyanins | 19.4 ± 78.9 mg/100 g | [16] |
| Steroid | — | [71] |
| Glycosides | — | [12] |
| | — | [68] |
| Terpenoids | — | [12] |
| | — | |
| Tannins | 0.04776 $\mu$g/ml | [72] |
| | — | [68] |
| | 76.90°C 88 mg/100 g | [16] |
| Ascorbic acid | 17.1 ± 34.56 mg/g | [78] |
| | 135.2 mg/100 g | [16] |
| Saponin | 255,000 $\mu$g/ml | [72] |
| | | [68] |
| Lutein | 692 $\mu$g/g | [76] |
| ?-carotene | 326 $\mu$g/g | |
| Caffeic acid | 209 $\mu$g/g | |
| Kaempferol | 136 $\mu$g/g | |
| Phytosterol | — | [68] |
| Gum and mucilages | — | |
| Reducing sugars | 7.67 ± 0.4 mg/g | [69] |
| | 9.53 ± 0.4 mg/g | |
| Sucrose | 54.8 ± 4.1 mg/g | |
| | 71.1 ± 4.7 mg/g | |
| Polyphenols | 217.6 ± 256.7 mg/100 g | [16] |

*aureus*, while the water extract showed greater activity against *S. typhimurium*.

Linguarajo et al. [12] confirmed the inhibition of the bacteria *E. coli* (zone of inhibition 17 mm), *P. aeruginosa* (zone of inhibition 28 mm), *Bacillus subtilis* (zone of inhibition 20 mm), *S. aureus* (zone of inhibition 25 mm), and fungus *C. albicans* (zone of inhibition 18 mm) when using the organic solvent, ethyl acetate, due to its higher con- centration of bioactive agents. Therefore, the authors con- firmed the microbial activities of *E. foetidum* in traditional medicine. The plant is used in Karnataka, India, in the form of tea and plaster for intestinal disorders and wound healing, respectively.

*6.2. Antioxidant Activity.* Four texts about the antioxidant activity of *E. foetidum* were registered between 2011 and 2021. It was observed that the locality, phenological phase, the analyzed part of the plant, and the extraction method influence the assessment of the oxidative potential of the species.

Certain bioactive compounds present in the essential oils of plants have the function of protecting cells from the harmful effect of reactive oxygen species and are therefore called *natural antioxidants*. They delay the degeneration processes related to aging and diseases such as cancer, car- diovascular disease, and neurodegenerative disorders [16]. Singh et al. [16] quantified the extraction of chemical com- pounds from *E. foetidum* leaves and found greater concen- trations in acetone and methanol solvents, which were rich in polyphenol, tannin, anthocyanin, flavonoids, carotenoids, and ascorbic acid. These findings indicate that this plant has high potential for the pharmaceutical and food industry [16].

Thomas et al. evaluated the antioxidant activity of *E. foetidum* leaves, roots, and stems through the free radical scavenging capacity of volatile oils using 2,2-diphenyl-1-picrylhydrazyl (DPPH) and ferric reducing antioxidant power (FRAP) assays. In the DPPH tests, the oils from leaves, stems, and roots presented $IC_{50}$ values of 56 $\mu$g/mL, 46 $\mu$g/mL, and respectively, while in the FRAP test, the leaf oil had the greatest reduction potential among the tested oils. Acyclic aldehydes and aromatic compounds, which are im- portant antioxidant agents, were also detected. Investigations by Nguyen [70], on the total phenolic, flavonoid, and anti-oxidant capacity of *E. foetidum* extract, determined that ex- traction with 60% ethanol, at 50°C, stirring duration of 30 minutes, particle size of 0.4 cm, and solid-liquid ratio of 1: 25 g/mL provided the highest total phenolic, flavonoid, and antioxidant capacity. These methods are relevant to obtain the highest concentration of bioactive compounds.

The antioxidant capacity of *E. foetidum* isinfluenced by the growth stage: in the juvenile stage, between 90 and 120 days after germination, there is greater production of bioactive compounds such as polyphenol and flavonoids with antioxidant activity in the leaves [69]. On the other hand, Castro-Alayo et al. [62] observed that in plants from 52 districts of the Amazon region in Peru, there was a variable yield, concentration, and antioxidant activity of the essential

Table 4: Pharmacological activities of bioactive compounds from *Eryngium foetidum* L.

| Pharmacological activity | Organism | Bioactive compounds | Ref. |
|---|---|---|---|
| Antibacterial and antifungal | *Helicobacter pylori* | Alkaloids, phenols, flavonoids, anthraquinone, sterols | [71] |
| | *Streptococcus pneumoniae*, *Listeria monocyatogenes*, *Staphylococcus aureus*, and *Salmonella* | Glycosides, flavonoids, terpenoids, steroids, and tannins | [12] |
| | | Phenolic compounds, ascorbic acid | [78] |
| | *Salmonella typhimurium* and *Candida albicans* | Flavonoids, tannins, alkaloids, phenolic compounds, steroids, and terpenoids | [72] |
| | *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus subsp. aureus* e *Streptococcus pneumoniae* | — | [80] |
| | *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli*, *Salmonella*, *Shigella sonnei*, *Shigella dysenteriae*, *Shigella flexneri*, and *Vibrio cholerae MTCC* | — | [79] |
| Anthelmintic | *Strongyloides stercoralis* | Trans-2-dodecenal | [13] |
| Anti-leishmaniasis | *Leishmania tarentolae* promastigotes and *Leishmania donovani* amastigotes | Lasidiol *p*-methoxybenzoate | [63] |
| Antilarval | *Aedes albopictus skuse* | 2-Dodecen-1-al, capryl alcohol | [14] |
| Anti-inflammatory | — | Lutein, $\beta$-carotenes, chlorogenic acid, kaempferol, and caffeic acid | [81] |
| | | $\beta$-Carotene, lutein, caffeic acid, and kaempferol | [76] |
| Anticlastogenic | — | — | [82] |
| Anticancer | — | — | [83] |
| Antidiabetic | — | Carbohydrates, starch, mucilage, proteins and amino acids, saponins, phytosterols, flavonoids, phenolic compounds, and tannins | [68] |
| Antioxidant | — | Polyphenols, flavonoids, chlorophylls, and carotenoids | [69] |
| | | carotenoids ($\beta$-carotene, $\beta$-cryptoxanthin, lutein, zeaxanthin, pheophytin-b, chlorophyll-a, and chlorophyll-b), phenolic compounds ( protocatechuic acid, p-coumaric acid, syringic acid ferulic acid, and sinapic acid, gallic acid) and anthroquinones (citreorosein, telochistin, secalonic acid D, emodin, parietin and norlichexanthone). | [16] |
| | | $\alpha$-Pinene, M-cymene, O-cymene, and (Z)-13-octadecenal | [62] |
| | | Phenols, flavonoids, and antioxidants | [70] |
| Toxicological | Causes renal dysfunction in mice, with a diet of 0.8% of consumption, equivalent to 35% of human consumption in 24 weeks | — | [84] |

oil of chicory. In this region, the most prominent volatile component was $\alpha$-pinene (23.41%) and the content of the essential oil varied among individuals, suggesting a variability associated with geographic location [62].

*6.3. Antifungal Activity.* Lingarajo et al. [12] and Borah et al. [72] evaluated the potential of extracts from *E. foetidum* leaves and found antifungal activity for *C. albicans*, with high inhibition. This shows that substances produced by the species can be useful to treat diseases caused by this path- ogen, such as infections of the gynecological tract. It also ratifies the efficiency of this plant when used for this purpose in traditional communities.

*6.4. Anti-Inflammatory Activity.* Anti-inflammatory action was also reported by Mekhora et al. [81] and Dawilai et al. [76]. Their data suggest a significant role in the suppression of the pro-inflammatory process and a high potential of the plant to be used as a food supplement to reduce the risk of cancer associated with inflammation. Other activities have been reported for the species, such as anticlastogenicity [82], antilarval [14], anticancer [83], antidiabetic [68], and toxicological [84] activities. Table 3 summarizes the pharmacological activities of *E. foetidum* and its bioactive compounds. Table 4 gathers the information about the pharmacological activities of the extract from *E. foetidum* in different microorganisms.

## 7. Conclusion

This study is the result of the collection of 88 documents, of which only 76 met the established criteria and were analyzed in full length.

*Eryngium foetidum* has a high potential for use in different areas of application. It is mainly reported to treat diseases related to the intestinal and gynecological tract, as

well as viral diseases and infections. The appreciation of traditional knowledge and eating habits are of inestimable importance to preserve its forms of use and edible biodiversity. Chicory leaves are widely used in food preparation, but few research papers were found on the subject. Thus, there is field for research to be carried out to provide a better understanding of the gastronomic cultural identity involving this species.

The volatile constituents and minerals present in the species have high pharmacological value, with strong antioxidant activity. The essential oils of *E. foetidum* are marked by aromatic and aliphatic aldehydes; (2E)-2-dodecenal is the major chemical constituent in the leaves, and 2,3,4-trimethylbenzaldehyde is the major chemical constituent in the roots. These substances are effective to treat diseases and can prevent oxidative deterioration in food. Other constituents such as alkaloids and anthraquinones were found, and these compounds have rarely been found in specimens of *E. foetidum* in the last ten years, suggesting that further re- search is needed on this group and its applications. The pharmacological tests reported in the analyzed works mentioned effective antibacterial, antioxidant, antifungal, and anti-inflammatory actions of *E. foetidum* extracts. In this sense, the effectiveness of the use of *E. foetidum* in ethnomedicine can be associated with these actions.

Few studies have assessed the toxic, antidiabetic, anticancer, and antilarval potential of *E. foetidum*, and thus, further research is needed to support the research already carried out and confirm the effectiveness of the use of this plant to treat other diseases.

## Data Availability

All supporting data are included within the article.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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## 4 Usos e conhecimento tradicional agronômico de *Eryngium foetidum* L. em comunidades agrícolas (Curuçambá e Campo Limpo) no estado do Pará- Amazônia- Brasil

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# USES AND TRADITIONAL AGRONOMIC KNOWLEDGE OF *Eryngium foetidum* L. IN AGRICULTURAL COMMUNITIES (CURUÇAMBÁ AND CAMPO LIMPO) OF THE STATE OF PARÁ – AMAZON - BRAZIL


## ABSTRACT

**Objective:** To analyze the sociocultural aspects that influence the traditional uses and management practices of the species *Eryngium foetidum* L. employed by family farmers in two Amazonian communities.

**Theoretical Framework:** *Eryngium foetidum* is a vegetable species widespread in the Amazon with significant food use due to the aroma of its leaves. It is important to investigate the traditional management by family farmers and the sociocultural factors that influence the cultivation of this species.

**Method:** Data were collected through exploratory visits and interviews with farmers. The study had a qualitative and quantitative approach, with descriptive statistics, word frequency analysis, and a regression analysis using R software, version 4.2.1.

**Results and Discussion:** Uses were only affected by the gender factor in the communities, while the age factor indicated a tendency towards new agronomic practices. The seeds used for cultivation of *E. foetidum* originated from previous crops, since there were no points of sale of seeds in the communities.

**Research Implications:** Divergent answers regarding the management of *E. foetidum* imply challenges for the planning of crops in terms of costs and profitability, demonstrating the fragility of both communities in terms of participation in the species' production chain in the region.

**Originality/Value:** For the first time in the literature, a report on how sociocultural factors affect the use and management of *E. foetidum* is presented. Thus, the recorded data contribute to the formation of the species' production chain.


**Keywords:** Traditional management. Rural producers, Amazonian communities, Sociobiodiversity.

# USOS E CONHECIMENTO TRADICIONAL AGRONÔMICO DE *Eryngium foetidum* L. EM COMUNIDADES AGRÍCOLAS (CURUÇAMBÁ E CAMPO LIMPO) NO ESTADO DO PARÁ – AMAZÔNIA - BRASIL


## RESUMO

**Objetivo:** Analisar aspectos socioculturais influenciadores nos usos e práticas de manejo tradicionais da *Eryngium foetidum* L. pelos agricultores familiares de duas comunidades amazônicas.

**Referencial Teórico:** É fundamental investigar o manejo tradicional realizado por agricultores familiares e os fatores socioculturais que exercem efeito no cultivo de *E. foetidum.* É uma hortaliça difundida na Amazônia, com expressivo uso alimentício, devido ao aroma das folhas.

**Método:** Foram realizadas entrevistas com agricultores, por meio de formulário semiestruturado, a abordagem foi qualiquantitativa, com análises de estatística descritiva, frequência de palavras, além das análises de regressão no *software* R, versão 4.2.1.

**Resultados e Discussão:** Os usos são afetados apenas pelo fator gênero nas comunidades, enquanto o fator idade indicou tendência para novas práticas agronômicas. Constatou-se que as sementes utilizadas para o cultivo da espécie nas comunidades possuem origem dos cultivos anteriores, pois não há pontos de comercialização.

**Implicações da Pesquisa:** Divergências sobre o manejo de *E. foetidum* implicam em desafios para o planejamento dos cultivos, em custos e em lucratividade, demonstrando a fragilidade na participação da cadeia produtiva da espécie na região, por ambas as comunidades.

**Originalidade/Valor:** Pela primeira vez na literatura, foram relatados como fatores socioculturais podem afetar o uso e o manejo de *E. foetidum.* Dessa forma, foi possível registrar dados para contribuir com a formação da cadeia produtiva da espécie.


**Palavras-chave:** Manejo tradicional, Produtores rurais, Comunidades amazônicas, Sociobiodiversidade.

**USOS Y CONOCIMIENTOS AGRONÓMICOS TRADICIONALES DE *Eryngium foetidum* L. EN COMUNIDADES AGRÍCOLAS (CURUÇAMBÁ Y CAMPO LIMPO) DEL ESTADO DE PARÁ – AMAZONÍA - BRASIL**

**RESUMEN**

**Objetivo:** Analizar aspectos socioculturales que influyen en los usos y prácticas de manejo tradicionales de *Eryngium foetidum* L. por parte de agricultores familiares de dos comunidades amazónicas.

**Marco Teórico:** Es fundamental investigar el manejo tradicional que realizan los agricultores familiares y los factores socioculturales que inciden en el cultivo de *E. foetidum*, puesto que es una hortaliza muy común en la Amazonia, con importante uso alimenticio, por el aroma de las hojas.

**Método:** Los agricultores fueron entrevistados mediante un formulario semiestructurado. El enfoque fue cualitativo y cuantitativo, con análisis de estadística descriptiva, frecuencia de palabras, además de análisis de regresión en el software R, versión 4.2.1.

**Resultados y Discusión:** Los usos solo fueron afectados por el factor género en las comunidades, mientras que el factor edad indicó una tendencia a nuevas prácticas agronómicas. Las semillas utilizadas para cultivar la especie en las comunidades provenían de cultivos anteriores, ya que no existen puntos de comercialización.

**Implicaciones para la investigación:** Los desacuerdos respecto al manejo de *E. foetidum* implican desafíos para la planificación de cultivos, costos y rentabilidad, demostrando la fragilidad de la participación de las dos comunidades en la cadena productiva de la especie en la región.

**Originalidad/Valor:** Por primera vez en la literatura se informó cómo los factores socioculturales pueden afectar el uso y manejo de *E. foetidum*. De esta forma, fue posible registrar datos para contribuir a la formación de la cadena productiva de la especie.

**Palabras clave:** Gestión tradicional, Productores rurales, Comunidades amazónicas, Sociobiodiversidad.



## 1 INTRODUCTION

*Eryngium foetidum* L. is an herb native to the Amazon, popularly known as "Chicória-do-Pará" (Pará chicory) in the Northern region of Brazil, mainly cultivated by family farmers for domestic and commercial use (Rodrigues *et al.*, 2022). It is also recorded in Ecuador and Asia, where it is used as a food and medicinal plant (Rosero-Gómez *et al*., 2020; Devi *et al.*, 2021).

*Eryngium foetidum*'s chemical and nutritional properties (Kokilananthan *et al.*, 2023) has motivated the investigation of its chemical (Rodrigues *et al.*, 2022) and pharmacological (Hemachandra *et al.*, 2021) properties. However, regarding folk knowledge and crop management practices, little has been investigated, particularly concerning the biocultural diversity linked to this plant. Such information is an important driver for the formation of productive chains of native plant species.

Family farming has been the basis of the management systems of several native species considered sociobiodiversity products. These products are defined as service goods, generated

with local resources, aimed at forming production chains of interest to traditional peoples and family farmers (Brasil, 2009).

Sociobiodiversity product chains take into account ecological, social, economic, agronomic and cultural aspects to guide the entire process from cultivation, processing, to final consumer market (Lima *et al.*, 2021). The study of the dynamics of agriculture in different spaces can help identifying opportunities to increase and provide political incentive to promote agrobiodiversity (Heliodoro, 2021). It is assumed that the absence of actions, such as research aimed at the development of production chains, can hinder the sustainable use of native species and, consequently, their insertion into new markets.

Motivated by the need of valuing food plants from regional sociobiodiversity and the relevance of actions promoting food and nutritional sovereignty and security, as well as conserving native species (Ferreira & Bartachevits, 2022), here we report for the first time in the literature the sociocultural factors influencing the uses and agronomic management of *E. foetidum*. This study will contribute to the formation and strengthening of production chains and appreciation of native Amazonian food species.

The following guiding questions were formulated: Do sociocultural factors affect the medicinal and food uses of *E. foetidum*? What sociocultural factors affect the management of this species? The objective of the study was to describe the traditional uses and management of *E. foetidum* and investigate the effect of sociocultural factors on the practices of producers from two agricultural communities in the Amazon region of the state of Pará, Brazil.

## 2 THEORETICAL BACKGROUND

Sociobiodiversity product chains have the potential of promoting economic activities that value biodiversity and natural resources, promoting improvements in the quality of life of local populations with greater ecological harmony and social justice (Oliveira Júnior *et al.*, 2018). Family agricultural production is the key point to start the development of productive chains of native plants, since they incorporate cultural identity, values and traditional, material and immaterial knowledge considered as heritage of humanity (Krag & Santana, 2017).

Regarding the dynamics of use and management of native plants by family farmers, it is noted that, in some more developed chains in Pará, the sociocultural aspects of producers are decisive for the results achieved by communities in the use of species for the establishment of production chains. For example, in the study by Almeida *et al.* (2021) in the rural communities of Anapú, Caji and Meruú, in Igarapé-Miri, Pará, the profile of açaí producers showed the predominance of males, single marital status and length of residence over 40 years. The inheritance of areas from the parents was a factor that explained the rich knowledge about

management practices and production of the açaí fruit, and socioeconomic factors were essential to guide the establishment of public policies to strengthen the açaí production chain in the municipality. The same can be said for other products related to the sociobiodiversity of the Amazon.

Social factors related to production and management are intrinsically linked to the local dynamics of agricultural communities and they should be included in action plans to structure the base of production chains, as well as its other segments such as processing, storage, transport and commercial logistics. This allows us to build a new perspective of the production of native medicinal and food species (Ramírez *et al.*, 2020).

Researchers have recognized in their studies the importance of sociocultural aspects and agents that make up the sociobiodiversity product chains. Borges *et al.* (2022) emphasized that the market for leafy vegetables grown essentially within the scope of family farming has great potential in the state of Pará, but faces challenges such as the absence of public policies that effectively meet the needs of producers. Family farming is considered one of the most efficient forms of using and occupying areas for crops, besides being environmentally friendly and a source of income. Furthermore, traditional knowledge forms the basis for strategies to create new product chains (Oliveira Júnior *et al.*, 2018).

Ferreira-Alves and Santos-Fita (2023) showed that the advance of monocultures in Santa Luzia, northeast of Pará, currently threatens the cultivation of 27 ethnovarieties of cassava. The weakening of traditional agronomic practices in the community is evidence of it.

Rodrigues *et al.* (2022) pointed out that *E. foetidum* is among the herbs that make up cultural identity for the Northern region of Brazil, especially in the Metropolitan Region of Belém. Locally known as “Chicória-do-Pará”, this plant is an essential ingredient in typical preparations of local gastronomy and has high potential for medicinal use. However, we know little about the production chain of this plant in the region. Therefore, it is important to understand the dynamics of the sociocultural aspects involved in the traditional cultivation of native plants as sociobiodiversity products.

## 3 METHODOLOGY

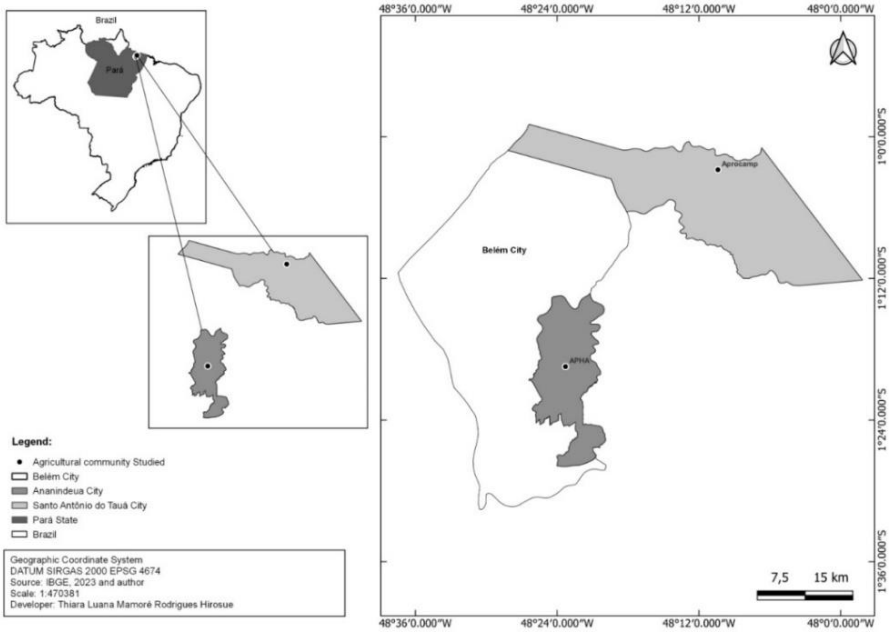
### 3.1 LOCATION AND CHARACTERIZATION OF THE AREA FOR COLLECTION OF INFORMATION

The study was carried out in two communities in Pará: Curuçambá (1°19' 28.55" S and 48° 23'16.96" W) and Campo Limpo. The former is located in the municipality of Ananindeua (Pará) and the family farmers are linked to the Association of Horticultural Producers of Gleba Guajará (APHA), and the later is located in the municipality of Santo Antônio do Tauá, where

farmers are linked to the Association of Rural Producers of the Campo Limpo Community (APROCAMP) (Figure 1).

**Figure 1**

*Location of the study area, indicating the communities studied to characterize the cultivation of* Eryngium foetidum *L. in the municipalities of Ananindeua and Santo Antônio do Tauá, Pará, Brazil.*




3.2 SAMPLING PROCEDURES AND PARTICIPANTS

The study followed the ethical procedures in accordance with Resolution 466/2012, which regulates research with human beings. The project was initially registered on "Plataforma Brasil" (http://plataformabrasil.saude.gov.br) under the protocol CAAE 51198220.8.0000.5168 and approved by the Research Ethics Committee (REC), according to Opinion number 5.074.408. Farmers who agreed to participate were invited to read and sign the Informed Consent Form (ICF), structured in accordance with Resolution 466/12. It is important to note that all stages started only after the project was approved by the REC/Conep system.

This study was conducted with family farmers who cultivate *E. foetidum,* over 18 years of age, of both genders. We interviewed all farmers who agreed to participate in the study: 28 farmers in Curuçambá and 20 in Campo Limpo. Thus, non-probabilistic convenience sampling was used. The duration of the interviews was adapted according to the availability of time and working hours of the family.

3.3 DATA COLLECTION AND ANALYSIS

Data were collected between August 2021 and July 2022. Initially, visits were made to the communities before starting the field research phase in order to explore the organization

and social arrangements. Interviews were conducted with the aid of questionnaires with semi-structured questions, in which the participant is free to answer the questions. Complementary information was collected concomitantly in a field journal. Photographic records were associated with guided tours, a field work technique in which the interlocutor with local knowledge is invited to present the spaces where the species is cultivated and/or conserved (Albuquerque *et al*., 2014).

The interviews were conducted with a member of the Family Unit (FU) who was willing to participate in the study. To this end, the forms were organized into three sections: I. sociocultural information, including age, gender, place of birth, marital status, place of residence, time working as a farmer; II. forms of use of *E. foetidum*, including medicinal and food use, and whether there is commercialization and/or local consumption; and III. traditional management of the species by family farmers: soil management, fertilization used in crops, origin of seeds, type of sowing, plant production cycle and spacing used in cultivation beds.

Data were processed and analyzed using descriptive statistics. In addition, a qualitative content analysis was performed including the technique of thematic categories with word frequencies (Bardin, 2011). A regression analysis was used for statistical testing in the R software, version 4.2.1 (R Core Team, 2022). The Shapiro-Wilk test was used to check the normality of the data and the Spearman correlation test to evaluate the correlations between the predictor variables in the construction of the models. No correlation was found between any variable except for age and time working as a farmer, and thus a linear regression analysis was performed. The following categorical predictor variables were considered: gender (male and female), age (between 18 and 23 years, 24 and 30 years, 31 and 40 years, 41 and 50 years, 51 and 60 years and over 60 years) and place of birth (Pará or another state).

For the block on uses, the following response variables were used: I. total number of food uses indicated for the plant (the value is equivalent to the total number of recipes with *E. foetidum*); II. total number of medicinal uses; and III. indication for both medicinal and food uses (1 for yes and 0 for no). For the agronomic section, the following response variables were selected: I. liming use (1 for yes and 0 for no); and II. the informant produces the fertilizer he/she uses (1 for yes and 0 for no).

## 4 RESULTS AND DISCUSSIONS

### 4.1 PROFILE OF FARMERS IN COMMUNITIES

The sociocultural data of the farmers interviewed in the two communities are presented in Table 1.

**Table 1**

*Characterization of the interviewed family farmers from each community included in the sample*

| Variables | Campo Limpo | | Curuçambá | | Total | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| Gender | | | | | | |
| Female | 10 | 50.00 | 18 | 64.29 | 28 | 58.33 |
| Male | 10 | 50.00 | 10 | 35.71 | 20 | 41.67 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |
| Place of birth | | | | | | |
| Pará | 20 | 100.00 | 23 | 82.14 | 43 | 89.58 |
| Ceará | 0 | 0.00 | 3 | 10.97 | 3 | 6.25 |
| Maranhão | 0 | 0.00 | 2 | 7.14 | 2 | 4.17 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |
| Residence | | | | | | |
| Rural area | 20 | 100.00 | 14 | 50.00 | 34 | 70.83 |
| Urban area | 0 | 0.00 | 14 | 50.00 | 14 | 29.17 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |
| Marital status | | | | | | |
| Widowed | 1 | 5.00 | 2 | 7.14 | 3 | 6.25 |
| Single | 4 | 20.00 | 8 | 28.57 | 12 | 25.00 |
| Married/common-law married | 15 | 75.00 | 16 | 57.14 | 31 | 64.58 |
| Divorced | 0 | 0.00 | 2 | 7.14 | 2 | 4.17 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |
| Age group (years) | | | | | | |
| 18 to 23 | 3 | 15.00 | 1 | 3.57 | 4 | 8.33 |
| 24 to 30 | 0 | 0.00 | 5 | 17.86 | 5 | 10.42 |
| 31 to 40 | 8 | 40.00 | 2 | 7.14 | 10 | 20.83 |
| 41 to 50 | 5 | 25.00 | 8 | 28.57 | 13 | 27.08 |
| 51 to 60 | 3 | 15.00 | 8 | 28.57 | 11 | 22.92 |
| Over 60 | 1 | 5.00 | 4 | 14.29 | 5 | 10.42 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |

## 4.2 TRADITIONAL USES OF *E. foetidum*

### 4.2.1 Descriptive data

All farmers (100%) from both communities answered that they consumed the plants they produced (Table 2).

**Table 2**
*Number of mentions of food and medicinal uses of* Eryngium foetidum *L. among the participants in the communities of Campo Limpo and Curuçambá, Pará, Brazil.*

| Family use | Campo Limpo | | Curuçambá | | Total | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| Food and medicinal | 13 | 65.00 | 4 | 14.29 | 17 | 35.42 |
| Food only | 7 | 35.00 | 24 | 85.71 | 31 | 64.58 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |

In Curuçambá, *E. foetidum* is consumed only as a food plant, while in Campo Limpo the species is used for food and medicinal purposes (Table 2). Curuçambá is a peri-urban community in Ananindeua and, therefore, people has greater access to health professionals due to the proximity to medical care centers and drugstores (Sodré & Cardoso, 2019).

The frequency of mentions of the use of different plant parts in food preparations in the communities is presented in Table 3.

**Table 3**
*Number of mentions of food preparations using leaves and roots of* Eryngium foetidum *L. among the participants in the communities of Campo Limpo and Curuçambá, Pará, Brazil.*

| Part of the plant used for food purposes | Campo Limpo | | Curuçambá | | Total | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| Leaves | 19 | 95.00 | 27 | 96.43 | 46 | 95.83 |
| Roots | 1 | 5.00 | 1 | 3.57 | 2 | 4.17 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |

Leaves were more used in traditional food preparations because of the flavor and aroma they give to the dishes (Table 3). This information was also confirmed in the study by Rodrigues *et al*. (2019), who identified the chemical profile of the essential oils of leaves and roots and found that (2E)-2-dodecenal, the major constituent present in the leaves, is responsible for the peculiar aroma of the species that makes it attractive for consumption.

**Table 4**
*Food preparations using* Eryngium foetidum *L. according to the number of mentions in the communities of Campo Limpo and Curuçambá, Pará, Brazil.*

| Category | Food | n | % |
|---|---|---|---|
| Main dish | Fish | 40 | 83.33 |
| | Chicken | 19 | 39.58 |
| | Meat | 9 | 18.75 |
| | Rustic chicken | 4 | 8.33 |
| | Soup | 3 | 6.25 |
| | Maniçoba[1] | 1 | 2.08 |
| Side dish | Beans | 44 | 91.67 |
| | Rice | 20 | 41.67 |
| | Tucupi[2] | 12 | 25.00 |
| | Salad | 2 | 4.17 |
| | Baião[3] | 1 | 2.08 |
| | Farofa[4] | 1 | 2.08 |

[1] Indigenous dish typical of Pará, Brazil, made with the leaves of wild cassava, which are ground and cooked for seven days with salted or smoked beef and pork and spices.
[2] A yellow liquid extracted from the root of wild cassava widely used as an ingredient in Amazonian cuisine.
[3] A typical dish from Northeast Brazil made with rice, beans and spices.
[4] Flour made from cassava roots, which are grated, dried, ground and fried with butter or fat, enriched with herbs, onion and garlic.

In the survey of the traditional knowledge about the use of *E. foetidum* in food preparations, fish was cited more frenquetly as the main dish and beans and rice as side dishes (Table 4).

Most respondents in both communities indicated the use of roots for medicinal purposes (Table 5) to treat various health problems, including pain, infections and inflammation (Table 6).

**Table 5**
*Uses of plant organs of* Eryngium foetidum *L. for medicinal purposes according to the number of mentions in the communities of Campo Limpo and Curuçambá, Pará, Brazil.*

| Plant part used | Campo Limpo | | Curuçambá | | Total | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |

| | | | | | | |
|---|---|---|---|---|---|---|
| Roots | 11 | 73.33 | 10 | 76.92 | 21 | 75.00 |
| Leaves and roots | 2 | 13.33 | 1 | 7.69 | 3 | 10.71 |
| Leaves | 2 | 13.33 | 0 | 0.00 | 2 | 7.14 |
| Flowers (inflorescences) | 0 | 0.00 | 2 | 15.38 | 2 | 7.14 |
| Total | 15 | 100.00 | 13 | 100.00 | 28 | 100.00 |

**Table 6**
*Uses of leaves and roots of* Eryngium foetidum *L. for medicinal purposes by farmers according to the number of mentions in the communities of Campo Limpo and Curuçambá, Pará, Brazil.*

| Medicinal use of leaves | Campo Limpo | | Curuçambá | | Total | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| Thick syrup to treat sore throat | 0 | 0.00 | 1 | 100.00 | 1 | 20.00 |
| Treatment of colic pains | 1 | 25.00 | 0 | 0.00 | 1 | 20.00 |
| Green juice and/or tea to treat stomach and bowel problems | 2 | 50.00 | 0 | 0.00 | 2 | 40.00 |
| Tea to fight nematodes | 1 | 25.00 | 0 | 0.00 | 1 | 20.00 |
| Total | 4 | 100.00 | 1 | 100.00 | 5 | 100.00 |
| Medicinal use of roots | | | | | | |
| Treatment of pain (menstrual cramps, stomach ache, toothache) | 3 | 23.08 | 3 | 30.00 | 6 | 26.09 |
| Treatment of inflammation | 5 | 38.46 | 1 | 10.00 | 6 | 26.09 |
| Treatment of pain and inflammation | 3 | 23.08 | 1 | 10.00 | 4 | 17.39 |
| Treatment of worms | 1 | 7.69 | 3 | 30.00 | 4 | 17.39 |
| Treatment of pain and infections | 0 | 0.00 | 1 | 10.00 | 1 | 4.35 |
| Treatment of liver diseases | 0 | 0.00 | 1 | 10.00 | 1 | 4.35 |
| Treatment of inflammations and infections | 1 | 7.69 | 0 | 0.00 | 1 | 4.35 |
| Total | 13 | 100.00 | 10 | 100.00 | 23 | 100.00 |

The roots of *E. foetidum* have a greater number of uses in the literature, such as analgesic, anti-inflammatory and vermifuge uses. They are commonly consumed in the form of teas and infusions, as they have a high content of 2,3,4-trimethylbenzaldehyde, a chemical constituent with famacological action (Rodrigues *et al*., 2022).

### 4.2.2 Statistical data

Only the factor "gender" had a significant effect on the response variable "number of recipes using *E. foetidum*" [Pr(>|z|) = 0.0457] as informed by farmers in the communities of Campo Limpo and Curuçambá (Table 7).

**Table 7**
*Significant model with Pr (>|z|) values considering the number of recipes using* Eryngium foetidum *L. as a function of sociocultural factors as informed by farmers in the communities of Campo Limpo and Curuçambá, Pará, Brazil.*

| Model 1 (gender + place of birth + age) | | | | |
|---|---|---|---|---|
| Coefficients | | | | |
| Estimate | Std. | Error | z Value | Pr(>\|z\|) |
| Intercept | 1.3673 | 0.9257 | 1.477 | 0.1468 |
| Gender | 0.8642 | 0.4204 | 2.056 | 0.0457* |
| Place of birth | 1.1865 | 0.6804 | 1.744 | 0.0882. |
| Age | 0.1169 | 0.1495 | 0.82 | 0.4385 |
| Residual standard error: 1.4323 | | | | |

| | |
|---|---|
| Multiple r squared: 0.1535 | F statistic: 2.66 on 3 and 44 Df |
| Adjusted r squared: 0.09581 | P-Value: 0.05978 |

The statistical analysis revealed that in both communities investigated women mentioned a greater number of recipes using *E. foetidum*. This result illustrates the outstanding role of women in the conservation of agrobiodiversity. This role stems from the natural relationship of women with activities related to family care, when it comes to food security in rural areas. In this regard, the main contribution of women in rural spaces to the conservation of cultivated biodiversity comes from the practices of maintaining and promoting this knowledge, supported by the cultivation and exchange of valuable seeds between groups and associations of women farmers (Mairesse & Biondo, 2022).

## 4.3 TRADITIONAL AGRONOMIC MANAGEMENT OF *E. foetidum*

### 4.3.1 Descriptive data

Aspects related to soil preparation for the cultivation of *E. foetidum* by communities are shown in Table 8.

**Table 8**

*Liming for soil preparation, type of fertilizer used, and local production of fertilizer by the farmers to be used in the cultivation of* Eryngium foetidum *L. in the communities of Campo Limpo and Curuçambá, Pará, Brazil.*

| | Campo Limpo | | Curuçambá | | Total | |
|---|---|---|---|---|---|---|
| Liming | n | % | n | % | n | % |
| No | 2 | 10.00 | 11 | 39.29 | 13 | 27.08 |
| Yes | 18 | 90.00 | 17 | 60.71 | 35 | 72.92 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |
| Fertilizer used | | | | | | |
| Animal and plant origin | 18 | 94.74 | 3 | 10.71 | 21 | 44.68 |
| Animal origin | 0 | 0.00 | 19 | 67.86 | 19 | 40.43 |
| Mineral origin | 0 | 0.00 | 2 | 7.14 | 2 | 4.26 |
| Plant origin | 1 | 5.26 | 0 | 0.00 | 1 | 2.13 |
| Animal and mineral origin | 0 | 0.00 | 2 | 7.14 | 2 | 4.26 |
| Fertilizer of animal, mineral and plant origin | 0 | 0.00 | 2 | 7.14 | 2 | 4.26 |
| Total | 19 | 100.00 | 28 | 100.00 | 47 | 100.00 |
| Local production of the fertilizer used | | | | | | |
| No | 4 | 20.00 | 19 | 67.86 | 23 | 47.92 |
| Yes | 16 | 80.00 | 0 | 0.00 | 16 | 33.33 |
| Buy and produce | 0 | 0.00 | 9 | 32.14 | 9 | 18.75 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |

Regarding soil preparation for the cultivation of *E. foetidum*, 90.0% of farmers in Campo Limpo and 60.71% in Curuçambá applied limestone on the soil. Although it is reported in the literature that *E. foetidum* emerges spontaneously in domestic backyards and on edges of roadways (Rodrigues *et al.*, 2019), soil management is necessary when cultivation is aimed at agricultural production on a larger scale. Amazonian soils have a potential of hydrogen (pH) below 5.5, which can be harmful for vegetable crops. Thus, a practice adopted in the area of

horticulture is liming. Liming is employed to raise the pH from 5.5 to 6.5, because in this acidity range, nutrients become available in the soil for plants to absorb and, consequently, there is an increase in production (Galvão *et al.*, 2020).

Organic fertilizers of plant and animal origin used in the community of Campo Limpo were produced through the composting technique using a composting time of 90 days, while in Curuçambá, commercial fertilizers of animal origin (chicken manure) were more frequently mentioned. According to Lobo and Grassi Filho (2023), organic fertilization increases the content of nitrogen in the soil, the nutrient responsible for plant growth. Rodrigues *et al.* (2019) found that higher leaf biomass was obtained in the cultivation of *E. foetidum* when an organic fertilizer was used.

In both communities, all family farmers carried out irrigation in the cultivation of *E. foetidum*, using manual irrigation or hand sprinklers (Table 09).

**Table 09**
*Types of irrigation used in the cultivation of* Eryngium foetidum *L. in the communities of Campo Limpo and Curuçambá, Pará, Brazil.*

| | Campo Limpo | | Curuçambá | | Total | |
|---|---|---|---|---|---|---|
| Irrigation | n | % | n | % | n | % |
| Yes | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |
| Irrigation type | | | | | | |
| Manual (hose) | 2 | 10.00 | 27 | 96.43 | 29 | 60.42 |
| Hand sprinklers | 18 | 90.00 | 0 | 0.00 | 18 | 37.50 |
| Automated sprinklers | 0 | 0.00 | 1 | 3.57 | 1 | 2.08 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |

Although farmers in both communities used irrigation to improve productivity, irrigation was not performed with precise control. According to Marouelli and Braga (2016), excess water can have a negative effect on gas exchange in the soil and root respiration, and favors the emergence of plant diseases, all factors that can affect the development of the crop. However, the authors reinforced that irrigation depends on climatic factors and that irrigation in vegetable crops must be light and frequent. Another important aspect is to avoid hampering seed germination and development of seedlings.

As for the origin of the seeds used in Campo Limpo and Curuçambá, most farmers used seeds from their own crops. This information is also cited by Silva et al. (2026). However, there were differences between the types of sowing used in the production of *E. foetidum* (Table 10). Cardoso and Silva Filho (1997) demonstrated that direct sowing *E. foetidum* in seedbeds with later thinning is more used in domestic-scale production. In turn, when the cultivation is aimed at commercialization, seeds are more commonly sown in seedbeds and after some time seedlings are transplanted to the final location (Cardoso & Silva Filho, 1997).

**Table 10**
*Seed origin and type of sowing used in the cultivation of* Eryngium foetidum *L. in the communities of Campo Limpo and Curuçambá, Pará, Brazil.*

| | Campo Limpo | | Curuçambá | | Total | |
|---|---|---|---|---|---|---|
| Seed origin | n | % | n | % | n | % |
| Own crops | 17 | 85.00 | 28 | 100.00 | 45 | 93.75 |
| Own crops and donation | 2 | 10.00 | 0 | 0.00 | 2 | 4.17 |
| Donation | 1 | 5.00 | 0 | 0.00 | 1 | 2.08 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |
| Type of sowing | | | | | | |
| Seedbed | 4 | 20.00 | 20 | 71.43 | 24 | 50.00 |
| Direct broadcast seeding | 16 | 80.00 | 8 | 28.57 | 24 | 50.00 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |

Regarding the spacing used in the cultivation of *E. foetidum*, there were significant differences in the techniques used among farmers (Table 11).

**Table 11**
*Spacing used in the cultivation of* Eryngium foetidum *L. in the communities of Campo Limpo and Curuçambá, Pará, Brazil.*

| | Campo Limpo | | Curuçambá | | Total | |
|---|---|---|---|---|---|---|
| Spacing | n | % | n | % | n | % |
| 10 cm | 2 | 10.00 | 10 | 35.71 | 12 | 25.00 |
| 12 cm | 0 | 0.00 | 5 | 17.86 | 5 | 10.42 |
| 13 cm | 0 | 0.00 | 2 | 7.14 | 2 | 4.17 |
| 15 cm | 11 | 55.00 | 1 | 3.57 | 12 | 25.00 |
| 20 cm | 6 | 30.00 | 6 | 21.43 | 12 | 25.00 |
| 25cm | 0 | 0.00 | 1 | 3.57 | 1 | 2.08 |
| 30 cm | 1 | 5.00 | 0 | 0.00 | 1 | 2.08 |
| Does not know | 0 | 0.00 | 3 | 10.71 | 3 | 6.25 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |

In Campo Limpo, most farmers used a 15 cm spacing to cultivate *E. foetidum.* In line with this finding, Gomes et al. (2013) stated that the highest productivity of *E. foetidum* was obtained when plants were grown with a spacing of 0.15 x 0.15 m.

The information given by the respondents on the time between sowing and harvesting and the number of *E. foetidum* plants grown per square meter is presented in Table 12.

**Table 12**
Time between sowing and harvesting and number of plants of Eryngium foetidum L. *produced per $m^2$ in the communities of Campo Limpo and Curuçambá, Pará, Brazil.*

| | Campo Limpo | | Curuçambá | | Total | |
|---|---|---|---|---|---|---|
| Time between sowing and harvesting | n | % | n | % | n | % |
| 60 days | 3 | 15.00 | 10 | 35.71 | 13 | 27.08 |
| 70 days | 1 | 5.00 | 0 | 0.00 | 1 | 2.08 |
| 90 days | 11 | 55.00 | 15 | 53.57 | 26 | 54.17 |
| 45 days | 0 | 0.00 | 2 | 7.14 | 2 | 4.17 |
| 120 days | 5 | 25.00 | 1 | 3.57 | 6 | 12.50 |
| Total | 20 | 100.00 | 28 | 100.00 | 48 | 100.00 |
| Number of plants produced per $m^2$ | | | | | | |
| 20 plants | 0 | 0.00 | 1 | 3.57 | 1 | 2.13 |
| 25 plants | 0 | 0.00 | 2 | 7.14 | 2 | 4.26 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 30 plants | 1 | 5.26 | 2 | 7.14 | 3 | 6.38 |
| 60 plants | 0 | 0.00 | 1 | 3.57 | 1 | 2.13 |
| Does not know | 18 | 94.74 | 22 | 78.57 | 40 | 85.11 |
| Total | 19 | 100.00 | 28 | 100.00 | 47 | 100.00 |

Regarding the time between sowing and harvesting, 55.00% and 53.57% of the producers in Campo limpo and Curuçambá, respectively, answered that this cycle is completed within 90 days. However, 94.74% and 78.57% of the interviewees from Campo limpo and Curuçambá, respectively, answered that they had little knowledge about the duration of the life cycle of the plant, what has negative implications for the planning of the staggered planting of *E. foetidum* in the communities.

### 4.3.2 Statistical data

The statistical analysis indicated that the factor "age" had a significant effect on the response variable "liming" for cultivation of *E. foetidum* by farmers in the communities of Campo Limpo and Curuçambá.

**Table 13**
*Significant model with Pr (>|z|) values considering the variable liming as a function of sociocultural factors in the production of* Eryngium foetidum *L. as informed by farmers in the communities of Campo Limpo and Curuçambá, Pará, Brazil.*

| Model 1 (gender + place of birth + age) | | | | |
|---|---|---|---|---|
| Coefficients | | | | |
| Estimate | Std. | Error | z value | Pr(>\|z\|) |
| (Intercept) | 0.85392 | 0.27651 | 3.088 | 0.003348** |
| Gender | -0.08459 | 0.12556 | 0.674 | 0.50403 |
| Place of birth | 0.30151 | 0.20323 | 1.484 | 0.14503 |
| Age | -0.09163 | 0.4464 | -2.052 | 0.04610* |
| Residual statand error: 0.425 | | | | |
| Multiple r squared: 0.1535 | | F statistic: 2.824 on 3 and 44 Df | | |
| Adjusted r squared: 0.1043 | | P-Value: 0.04958 | | |

The significant value of Pr(>|z|) 0.04610 indicates that age was important for the inclination of the farmers to adopt the use of liming, being the younger farmers the ones who did it most often, in both communities. That is, younger people are more likely to use limestone in *E. foetidum* crops than older people. The other factors (gender and place of birth) did not have a significat explanatory effect on liming.

The influence of the social aspect "age" on soil management in the cultivation of *E. foetidum* may be related to the practice of families of extracting the plants for their own consumption, still culturally practiced in traditional communities of Pará (Freitas *et al*., 2022). More recently, public policies have promoted the production and commercialization of sociobiodiversity products and raised the awareness about the value of traditional knowledge in rural areas by encouraging the conservation of agrobiodiversity, presenting an opportunity

for extra income and arousing the interest of younger farmers in the success of plant cultivation (Ramos *et al*., 2017; Freitas *et al*., 2022).

## 5 CONCLUSION

In this study, only the sociocultural factor "gender" affected the medicinal and food uses of *E. foetidum*, and the findings remarked the important role of women for the conservation of agrobiodiversity in the communities studied.

As for agronomic techniques, the fertilizers used in the communities had different sources and, therefore, there was no relationship between sociocultural factors and the use of fertilizers produced within the community, according to the statistical analyses. On the other hand, the factor "age" influenced the tendency to adopt new soil fertilization practices, which suggests interest on the part of younger farmers in improving the cultivation of *E. foetidum*. The seeds used in the crops came from the farmers' own production in both communities. This factor can be an obstacle when it comes to the formation of a production chain. There are gaps in studies aimed at the commercialization of *E. foetidum* seeds, with few records in the literature on this topic.

The divergent answers about the spacing used in the cultivation of *E. foetidum* and duration of the plant cycle in days and the lack of knowledge about the productivity per m² reflect the low degree of technical/scientific knowledge about the cultivation of this plant in the communities investigated. These aspects are hindrances to crop planning in terms of costs and profitability and they demonstrate the subsistent nature of the agronomic practices of these producers. Future studies should investigate the differences between rural and peri-urban agriculture, considering aspects other than sociocultural factors. For example, aspects related to the types of agricultural exploitation, land use and availability, labor cost, access to markets and inputs, availability of research and outreach services to subsidize public policies in accordance with the real needs of farmers who participate in the production chain of *E. foetidum*, a plant of great value in the region, need to be addressed.

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## 5 Traditional Usage and Market Presence of *Eryngium foetidum* L. in the Street Markets of Belém, Pará

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**Traditional Usage and Market Presence of *Eryngium foetidum* L. in the Street Markets of Belém, Pará**

**Abstract**: Understanding the diverse profiles of individuals involved in Amazonian production chains is crucial for effective marketing of native species. In this study, we examined the socio-cultural factors influencing the sellers and consumers of culantro (*Eryngium foetidum* L.) and their impact on marketing practices. Interviews with 301 participants, photographic records and direct observations were analyzed through generalized linear models (GLM) using R version 4.2.1. Regarding the profile of stallholders, the best-fitted models included age, while among consumers, gender and age played significant roles. Key findings highlighted that older stallholders sold culantro based on family traditions, and female consumers incorporated it into more recipes. The plant's leaves were commonly used as a food seasoning. This study is pioneer in the examination of agents shaping plant production chains, enhancing the connection between urban and rural areas. Despite its common use in home cuisine, culantro shows potential for broader applications in local, national, and international markets.

**Keywords**: Amazon. Aroma. Gender tradition. Ver-o-Peso market.

**Resumo**: Compreender os diversos perfis dos indivíduos envolvidos nas cadeias produtivas amazônicas é crucial para a comercialização eficaz das espécies nativas. Neste estudo, examinamos os fatores socioculturais que influenciam os vendedores e consumidores de culantro (*Eryngium foetidum* L.) e seu impacto nas práticas de mercado. Entrevistas com 301 participantes, registros fotográficos e observações diretas foram analisados por meio de modelos lineares generalizados (GLM) usando R versão 4.2.1. Em relação ao perfil dos feirantes, os modelos mais bem ajustados incluíram idade, enquanto entre os consumidores, gênero e idade desempenharam papéis significativos. As principais descobertas destacaram que os feirantes mais velhos vendiam culantro com base em tradições familiares, e as consumidoras o incorporavam em mais receitas. As folhas da planta eram comumente usadas como tempero alimentar. Este estudo é pioneiro no exame de agentes que moldam as cadeias de produção de plantas, aprimorando a conexão entre áreas urbanas e rurais. Apesar de seu uso comum na culinária doméstica, o culantro mostra potencial para aplicações mais amplas em mercados locais, nacionais e internacionais.

**Palavras-chave**: Amzônia. Aroma. Tradição de gênero. Mercado do Ver-o-Peso.

## INTRODUCTION

Biocultural diversity is based on the relationship between people and nature, encompasses biological and socio-cultural diversity, and may be associated with the economic activities of human populations (Miranda et al., 2021).

Seeking to recognize and value the knowledge of traditional peoples and communities, the Brazilian federal government created the National Plan for the Promotion of Socio-Biodiversity Product Chains, which is an instrument of participatory governance that involves multiple axes of action, such as knowing the profile of stallholders and consumers that may influence the practices of use and marketing, and determining the distribution and logistics routes of these products (Era et al., 2022a; MDA et al., 2009)

Some products and raw materials generated from socio-biodiversity resources are sold in street markets, places that articulate rural and urban organizations, add traditional knowledge, and promote employment and income (Era et al., 2022b; Silva Junior et al., 2022). Street markets are the object of much research in Brazil and include agents contributing to the formation and evolution of socio-biodiversity production chains [5].

In Brazil, non-conventional food plants promote diversity and quality in the human diet, contributing to food security, and are a source of income for production chain agents (Durigon et al., 2023). In the state of Pará, the study site of the present study, socio-biodiversity products generated a local income of R$ 4.24 billion (Brazilian reais), contributing significantly to the state's economy (Costa et al., 2022).

The success of the marketing of native medicinal and food plants in street markets is linked to several socio-cultural factors, such as gender, age, education level, and the place of origin of both stallholders and consumers (Carvalho et al., 2022). However, research focusing on this theme is generally descriptive; and the various socio-cultural factors that influence the dynamics of marketing socio-biodiverse products have been have investigated in few studies. Furthermore, specific resources are marketed through practices linked to the family traditions of a given location. For example, in the study by Costa et al., (2018) family members worked together in the market, helping to set up stalls and sell products, indicating the important role of family interaction and sharing of knowledge among members of different generations during this activity.

Although the fairs in Belém-PA have the primary function of supplying fresh products such as vegetables to consumers, they are not mere points of purchase and sale, but rather places with historical, social, economic, cultural and environmental relevance (Minnaert, 2008; Silva et al., 2013; Sousa et al., 2017). These socio-productive arrangements are a wide field for the research of relevant themes in the spheres of territoriality, traditions and culture. In the study

by Rabello et al. (Rabello et al., 2021) entitled “Boieiras do ver-o-peso: tradition, culture and non-economic values of regional cuisine in the most important fair in the Brazilian Amazon”, the authors showed that the ver-o-peso fair is integrated into the cultural heritage of Pará and represents a significant channel for food supply and a connection with the cultural and agro-productive production of small producers and riverside dwellers in the region.

(Andreoli et al., 2022) highlighted the importance of family traditions and the use of backyard-grown food plants because these traditions value the transmission of knowledge over generations and strengthen food identities. The participants of their study recalled the childhood memories in the gardens and backyards of their family members and the taste of homemade food prepared by grandparents, aunts, and uncles that involved using food plants. These findings revealed that the participants were guardians of knowledge about the use of unconventional food plants, highlighting the importance of family traditions in this context. Thus, in the present study, we investigate the role of different socio-cultural factors, including family traditions, in the marketing of important plant species native to the Amazon.

Culantro (*Eryngium foetidum* L.), an aromatic herb of the family Apiaceae known in Brazil as "*coentro-do-mato*," "*coentro-bravo*," and "*coentrão*", has great versatility of uses, particularly in food and medicinal preparations (Rodrigues et al., 2022). It is mainly cultivated by family farmers and marketed at street markets and small stores and, therefore, included in the group of plants that contribute to the family income of small producers and also to gastronomic tourism as an alternative for local development in the city of Belém (Corrêa et al., 2022).

Although *E. foetidum* is often used in traditional medicine in the South American continent, there is still a shortage of information on its use as food (Rodrigues et al., 2022). (Paul, 2011) and (Rodrigues et al., 2022) indicated that the food uses or other uses and the agents involved in the marketing of this plant have been little documented. Therefore, in the present study, we question which socio-cultural factors and actors that participate in the process of sale and use, stimulate the marketing and, consequently, move and strengthen the production chain of *E. foetidum*.

For this reason, this study proposes an analysis and discussion of the socio-cultural aspects of the different profiles of people involved in the marketing and use of *E. foetidum* in the street markets of Belém, Pará, Brazil. These markets who sell *E. foetidum* are authentic channels of distribution and marketing of food plants stemming from family farming that are used in daily life, both in simple and more refined dishes (Ferreira et al., 2020). Besides stallholders and domestic consumers, chefs play a key role in the dissemination of innovative recipes with food species. Thus, in addition to stallholders and consumers, the chefs of

restaurants located in Belém were invited to share their knowledge on the use of this species in cooking (Gewehr et al., 2022; Kato et al., 2020).

The COVID-19 pandemic imposed a series of challenges and limitations on social and commercial interactions worldwide, including the city of Belém. Stallholders selling traditional products such as *E. foetidum* faced significant difficulties due to the restrictions imposed to contain the spread of the virus. Social distancing measures and intermittent lockdowns directly impacted the stallholders' ability to market their products in the traditional manner. Open-air markets, essential venues for the sale of agricultural and medicinal products like *E. foetidum*, were temporarily closed or had their operations limited, thus reducing selling opportunities for the stallholders. Travel restrictions and decreased foot traffic in the streets affected the number of customers attending the markets. Many consumers chose to stay at home to minimize the risk of contagion, resulting in a lower demand for traditional products marketed by the stallholders. The economic hardships faced by many families during the pandemic also negatively influenced consumers' purchasing power. With fewer resources available, people reduced their spending on non-essential items.

Finally, concerns about food safety and hygiene during the pandemic may have also impacted the consumers' perceptions of products sold at the markets. Uncertainty about the origin and handling of food may have led some consumers to opt for food sources considered safer, such as supermarkets and online stores, at the expense of the street markets. Due to these limitations imposed by the COVID-19 pandemic, stallholders in the city of Belém have faced significant challenges to maintain their traditional business practices and provide for their families. Considering these difficulties is essential to understand how socio-cultural factors affect the marketing of traditional products like *E. foetidum* and the interaction dynamics with local food culture in Belém.

The present research aimed to investigate the sociocultural factors that involve the marketing of *E. foetidum* in open-air markets in Belém, Pará, Brazil and how these factors shape the complex set of variables that determine the commercialization and use of this herb. In this sense, what factors are affecting human behavior in the commercialization and uses of *E. foetidum* from the perspective of the local environment? What are their implications for understanding the formation of habits and cultural identity? The study also questions the extent to which origin, age and gender affect transgenerational knowledge of uses of this plant. In short, the research contributes to the dimensions of the sociocultural aspects of the *E. foetidum* marketing constellation and its importance in the free market in Belém, as well as to public policies that involve food security through the use of sociobiodiversity.

## MATERIALS AND METHODS

### LOCATION AND CHARACTERIZATION OF THE STUDY AREA

This study was conducted in Belém, Pará. The city has a population of approximately 1,303,403 (IBGE, 2023). Seven street markets were included: Ver-o-Peso, Guamá, 25 de setembro, Pedreira, Entroncamento, Bandeira Branca, and Icoaraci (8 de Maio) (Figure 1).

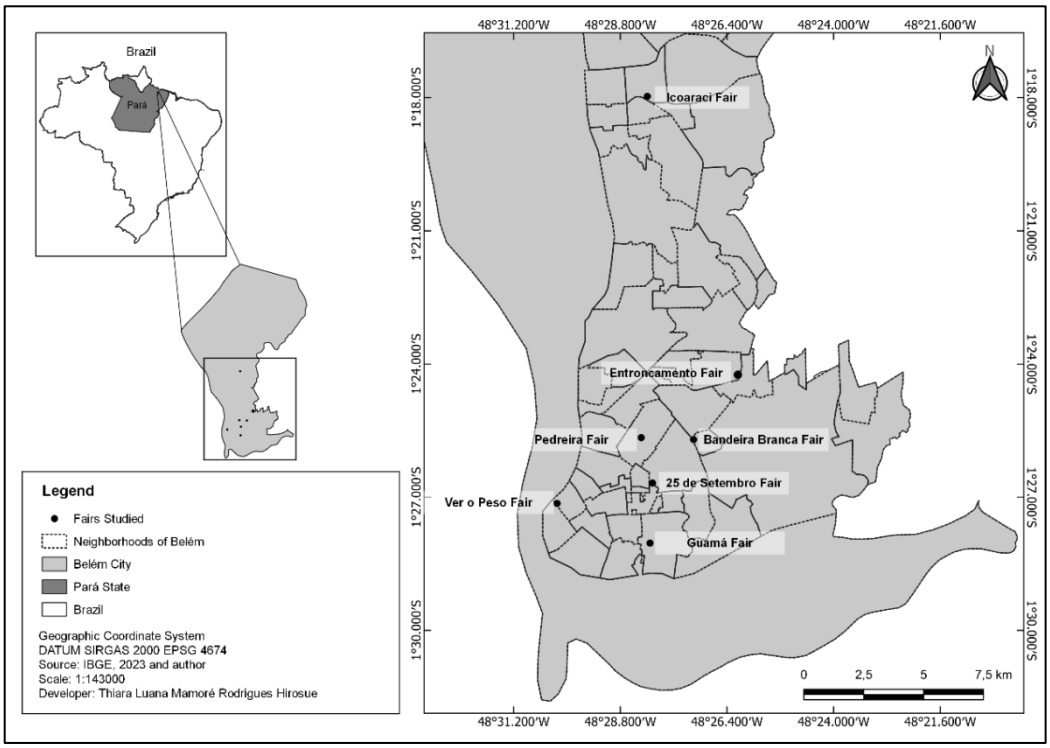


Figure 1: Location of the street markets included in this study where *Eryngium foetidum* L. is sold in the municipality of Belém, Pará, Brazil. Source: Prepared by the authors.

These markets were chosen for their significant footfall, sale of *E. foetidum*, and connections with rural areas. They played a crucial role in the mid-nineteenth century during the Amazonian rubber extraction cycle. Belem's street markets have been evolving since the 1900s and until present play a vital role in the food supply to the population and are unique due to their spatial characteristics (Araujo et al., 2018). Some markets like Ver-o-Peso date back to 1901 (Nunes et al., 2022; Pinheiro et al., 2023) They operate from 5 AM and serve as distribution channels for *E. foetidum*. The 8 de Maio market, the fourth largest, contributes significantly to the local economy (Raiol et al., 2019). The Guamá market, created in around 1930 and named after the river, serves the largest neighborhood in the city (Guimarães et al., 2018; Nunes et al., 2022). The Entroncamento market, located at the entrance of the city, was created in the 1970s (Teixeira et al., 2010). The 25 de Setembro market is the fifth largest and is situated on Romulo Maiorana Avenue (Costa Júnior, 2018). Bandeira Branca, in turn, is located in the Marco neighborhood, and the Pedreira market, created in the late nineteenth century, is located in one of the oldest neighborhoods of Belém (Nunes et al., 2022; Pinheiro et

al., 2023). This study also included restaurants featuring dishes from Para's gastronomic culture, like tacacá, arroz paraense, caldeirada, and maniçoba. Regarding the volume of transactions carried out in the markets, there are differences between markets and days or times of the year. For example, stallholders in Romulo Maiorana report that they sell approximately 100 branches with three specimens of *E. foetidum*, while stallholders in Entroncamento market sell 150- 200 per day. During festive seasons this volume can double or triple. The smallest volume is sold in Bandeira Branca: approximately 75 branches with three specimens per day. Figure 2 shows the display of the species sold at the fairs.

Figure 2: Marketing of *E. foetidum* at the markets of Belém, Pará. Source: Prepared by the authors.

## SAMPLING PROCEDURES AND PARTICIPANTS

Accidental non-probabilistic sampling, also known as convenience sampling (when there is no knowledge of the sampling universe), was adopted, through the intentional selection and interview of stallholders and consumers in the markets (Albuquerque et al., 2010). To select chefs, the snowball technique was used to identify restaurants selling regional food in Belém. This technique involves recruiting informants through indications of the participants of the

study. Also, searches were performed on Facebook, Instagram, and online ordering platforms such as iFood. The participants had three distinct profiles that reflected different stages of the production chain of the species, as detailed in Table 1.

Table 1: Number of stallholders and consumers in street markets participating in this study.

| **Street markets** | **No. of stallholders** | **No. of consumers** |
|---|---|---|
| Ver-o-Peso | 11 | 21 |
| Entroncamento | 15 | 25 |
| Bandeira Branca | 16 | 30 |
| 25 de Setembro | 14 | 30 |
| 8 de Maio | 17 | 27 |
| Pedreira | 13 | 28 |
| Guamá | 19 | 27 |
| Total | 105 | 188 |

1. STALLHOLDERS: People who worked and marketed *E. foetidum* in the markets. In total, 105 stallholders participated in the study and were selected based on their readiness to participate in interviews during the visits. According to the Brazilian Classification of Occupations (CBO 5242), stallholders are goods vendors at fixed points on public roads with government permission to exercise this activity (Classificação Brasileira de Ocupações CBO 5242, 2010).

2. DOMESTIC CONSUMERS: In this group, we prioritized people who consumed *E. foetidum* to create recipes and meals, approaching them at the seven markets. In total, 188 consumers were interviewed;

3. CHEFS: To select chefs, we initially identified restaurants in Belém with regional characteristics that used *E. foetidum* in their recipes. Thus, we included eight chefs from eight establishments. In this study, we considered chefs to be professionals responsible for creating elaborate recipes at the selected restaurants. According to the Brazilian Classification of Occupations (CBO 2711-05), these professionals perform activities such as creating and preparing dishes and menus, in addition to food preparation and managerial activities (Classificação Brasileira de Ocupações CBO 5242, 2010).

DATA COLLECTION

This research was registered on Plataforma Brasil, under protocol CAAE 51198220.8.0000.5168, approved according to opinion number 5,074,408, by the Ethics

Committee for Research with Human Beings of the State University of Pará – UEPA, Campus XII - Tapajós, located in Avenida Plácido de Castro, 1399, Santarém-PA**.**

The data were collected between February and July 2022. Initially, exploratory visits were made to the markets to obtain information about their spatial organization. Then, we initiated the direct observations and first contacts with stallholders and consumers (Albuquerque et al., 2010).

A pilot test was conducted to evaluate the forms to be used in the interviews with the stallholders and consumers. Initially, the forms consisted of both open- and closed-ended questions. However, the context of the COVID-19 pandemic and the spatial characteristics of the markets posed difficulties to the interaction between the researcher and the participants. Social distancing, continuous use of masks, the noisy environment and the intense flow of people, animals and vehicles around the stalls led to the need to adapt the forms. Thus, the form was composed of closed-ended questions and complemented with direct observations, field notes, and photographic records (Albuquerque et al., 2010). The visits were carried out for one week in each market; the first contacts were made from 8 a.m. to 12 p.m. from Monday to Thursday, and from 7 a.m. to 2 p.m. during the busiest days, namely, from Friday to Sunday.

In the first section of the form, socioeconomic information common to all groups was collected, namely, age, gender, nationality, marital status, place of residence, occupation, and education level. In the second section, the following specific aspects were addressed to each group: *Stallholders*: reason for choosing to sell *E. foetidum* in the market, origin (municipalities) of the plants sold; perception of sales, price, and number of bundles sold per week; main suppliers of the plant; and recognition of the varieties of the species; *Domestic consumers:* ways of use of the plant, recipes in which the plant was used, reason for using *E. foetidum*, meaning of consuming recipes containing *E. foetidum*, and importance of *E. foetidum* in daily food preparation.

For the group of chefs, the interviews were scheduled according to the availability of the respondents and conducted through semi-structured forms with open- and closed-ended questions using video calls through WhatsApp (Schmidt et al., 2020). The form addressed questions about why they used *E. foetidum* in their recipes, the benefits of the plant as an ingredient, the recipes in which the plant was used, innovative recipes under development, and acceptance to use the powdered form of the plant in the preparation of recipes.

## DATA ANALYSIS

Data were analyzed using descriptive and inferential statistics. Qualitative content analysis was also conducted, including a thematic categorical technique with word frequencies

(Bardin, 2011; Carlomagno et al., 2016). The statistical analyses included generalized linear models (GLM) performed in R software version 4.2.1. The Shapiro–Wilk test was used to check the normality of the data, and the Spearman correlation test was used to evaluate the correlations between the predictor variables to construct the models. Predictor variables showing significant correlations were inserted into different models.

In the stallholder group, GLMs were performed considering the following categorical predictor variables: gender (male and female), age (18–23 years, 24–30 years, 31–40 years, 41–50 years, 51–60 years, and over 60 years), education level (incomplete elementary school, complete elementary school, incomplete high school, complete high school, incomplete technical education, complete technical education, incomplete higher education, complete higher education, incomplete postgraduate education, and complete postgraduate education), and time of work as a stallholder (in years). The response variables were: I – reason for selling *E. foetidum* at the market (1 when family tradition was present in the answers, 0 otherwise); II –perception of sales of *E. foetidum* (1 for good, 2 for reasonable, 3 for bad); III – number of *E. foetidum* bundles sold per week; IV – main suppliers (in which case the participants could indicate "producer" or "middle person" and we assigned 1 for the presence and 0 for the absence of each main supplier mentioned); V – perception of price variation of *E. foetidum* throughout the year (1 when the participant perceived variation and 0 otherwise); VI – recognition of *E. foetidum* varieties (1 when the participant recognized the existence of varieties and 0 otherwise).

In the group of consumers, the GLMs were built considering gender, age, and education level as predictor variables, categorized in the same manner as in the models built for stallholders. In this case, the response variables were: I – number of dishes containing *E. foetidum;* II – primary use of *E. foetidum* (1 for medicinal preparations, 0 otherwise); III – use of *E. foetidum* motivated by family tradition (1 for yes, 0 otherwise); IV – regard of *E. foetidum* as indispensable for diet (1 for yes, 0 otherwise); and V – knowledge ofabout benefits of *E. foetidum* for maintaining health (1 for positive answers, 0 otherwise). After constructing the models, they were compared and those with lower Δ -AIC were considered the best fitted. The models were built using the Poisson or Binomial family depending on the nature of the response variable data. The Poisson family was used for data with a normal distribution and the Binomial family for binary data.

We also used the chi-square test to compare the proportions of people who resided in the municipality and people coming from other locations to buy *E. foetidum* in the markets. Additionally, a chi-square test of independence was performed to verify whether the proportions of men and women varied between the groups of stallholders and consumers. These analyses were performed using the R software, version 4.2.1.

## RESULTS

The percentages of study participants according to gender are presented in Figure 3, and their general characteristics are summarized in Table 2.

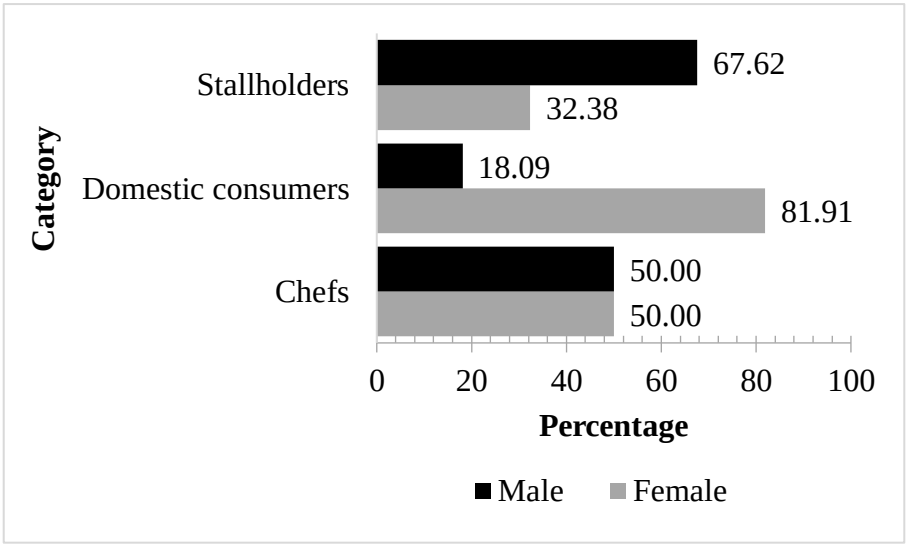


Figure 3. Frequency of the research participants according to gender.

Table 2. Education level, place of birth, origin, and age of the participants among the stallholders, consumers, and chefs (expressed as a percentage).

| Education Level | Stallholders | Consumers | Chefs |
|---|---|---|---|
| Did not attend school | - | 0.53 | - |
| Incomplete elementary school | 31.43 | 15.96 | - |
| Complete elementary school | 15.24 | 7.98 | 12.5 |
| Incomplete high school | 10.48 | 6.38 | 12.5 |
| Complete high school | 37.15 | 41.49 | 25 |
| Incomplete higher education | 1.90 | 2.13 | - |
| Complete higher education | 1.90 | 22.34 | 50 |
| Incomplete postgraduate education | - | 0.53 | - |
| Complete postgraduate education | 1.90 | 2.66 | - |
| **Place of birth** | | | |
| Pará | 98.10 | 87.78 | 75 |
| Maranhão | 1.90 | 4.79 | - |
| Amazonas | - | 2.13 | - |
| Amapá | - | 1.06 | - |
| Ceará | - | 1.06 | - |
| Piauí | - | 1.06 | - |
| Acre | - | 0.53 | - |
| Bahia | - | 0.53 | - |
| Rio Grande do Sul | - | 0.53 | - |
| São Paulo | - | 0.53 | - |
| Roraima | - | - | 12.5 |
| Rondônia | - | - | 12.5 |
| **Location** | | | |
| Urban area | 91.43 | 98.40 | 100 |
| Rural area | 8.57 | 1.60 | - |
| **Age range (years)** | | | |
| 18 to 23 | 8.57 | 0.53 | - |
| 24 to 30 | 5.71 | 1.60 | - |
| 31 to 40 | 11.43 | 12.77 | 37.5 |
| 41 to 50 | 30.48 | 29.25 | 25 |

| | | | |
|---|---|---|---|
| 51 to 60 | 29.52 | 26.60 | 37.5 |
| Over 60 | 14.29 | 29.25 | - |

STALLHOLDERS

The majority (81.90%) of the stallholders chose to sell *E. foetidum* in the market because the plant belongs to the vegetable group. Also, 20.95% of the stallholders sold the species because of family traditions and 11.43% because of its economic value. Figure 4 illustrates the frequency in which other vegetables are sold along with *E. foetidum* in the stalls.

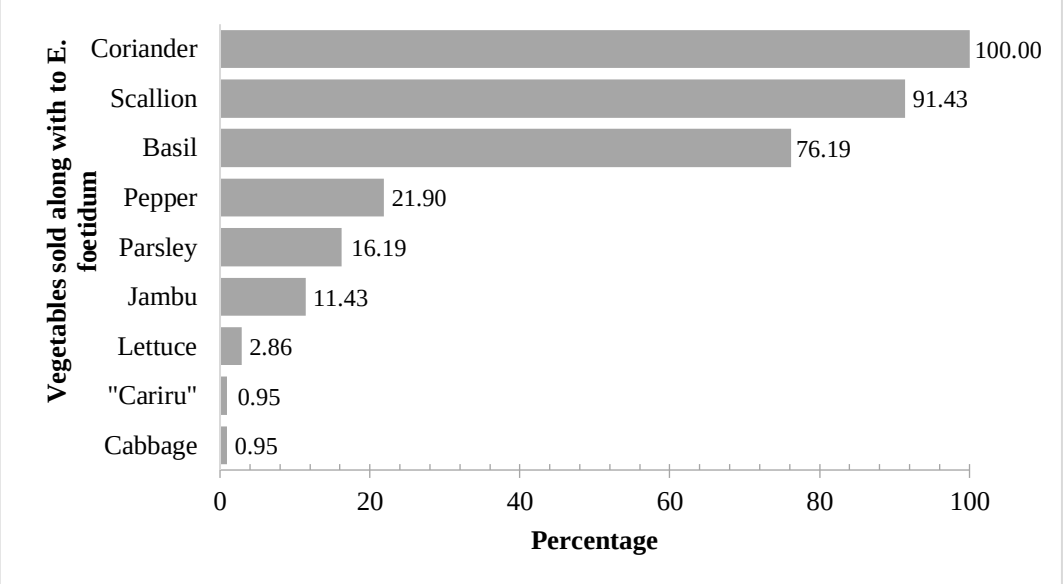


Figure 4: Frequency with which different vegetables were sold along *E. foetidum* according to responses of the stallholders.

As for the demand for *E. foetidum*, 78.10% of the stallholders reported that sales were good, 20.95% considered them reasonable, and 0.95% considered them bad. The number of bundles of *E. foetidum* sold per week ranged from 25 to 400 per stallholder, with purchase values ranging from R$ 0.50 to R$ 3.00 and sale values from R$ 1.00 to R$ 5.00.

Regarding the acquisition of *E. foetidum*, 45.71% of stallholders bought it directly from producers, and 45.76% bought it from middle people. Only 28.57% of the respondents recognized the existence of varieties. The different perceptions of the plant by the stallholders are listed in Table 3.

Table 3: Description of *Eryngium foetidum* varieties as recognized by stallholders.

| **Popular name** | **Characteristics** |
|---|---|
| *Língua-de-vaca* | Large leaves, thick leaves, smooth, without thorns, a little fragrant |
| *Graúda* | Large leaves and thick stalk |
| *Miudinha* | Small leaves, thorny, light green |
| *Cheirosinha* | Small leaves and fragrant |
| *Chicória-regional* | Small leaves and fragrant |
| *Chicória-do-roçado* | Thick leaves and resistant |
| *Chicória-do-quintal* | Small leaves and fragrant |
| *Chicória-do-interior* | Delicate leaves with a mild fragrance |

Table 4 presents the results of the comparisons of models performed for the group of stallholders. The best-fitted model, with the lowest value of Δi (0.0), included the variables age and education level. According to the best-fitted model (Table 5), age had a positive and significant effect on the indication of family tradition as a reason for selling the species, that is, older people were more likely to mention family traditions as a reason for selling the plant. The other variables had no significant influence on the mention of family tradition as a reason for selling plants in the market. None of the socio-cultural factors significantly affected the responses of the stallholders about the increase in prices throughout the year, the recognition of varieties of the species, the number of bundles sold per week, or the perception of *E. foetidum* sales.

Table 4: Comparison of best-fitted models showing Akaike's Information Criterion (AIC) values, degrees of freedom (df), differences in AIC values (Δi), and AIC weights values, regarding the effect of socio-cultural factors on the response variable "family tradition as a reason to sell *Eryngium foetidum*" among stallholders in street markets in the municipality of Belém, Pará, Brazil.

| Models (predictor variables) | AIC | Δi | df | Weight |
|---|---|---|---|---|
| Model 1: (age + education level) | 106.32 | 0.0 | 3 | 0.548 |
| Model 2: (gender + age) | 107.85 | 1.5 | 3 | 0.256 |
| Model 3: (education level + time) | 109.48 | 3.2 | 3 | 0.113 |
| Model 4: (gender + education level) | 110.61 | 4.3 | 3 | 0.064 |
| Model 5: (null) | 113.2 | 6.7 | 2 | 0.019 |

Table 5: Significant model with Pr(>|z|) values regarding the effect of socio-cultural factors on the response variable "family tradition as a reason to sell *Eryngium foetidum*" in street markets in the municipality of Belém, Pará, Brazil.

| Model 1 (age + education level) | | | | |
|---|---|---|---|---|
| Coefficients | | | | |
| **Estimate** | **Std.** | **Error** | **z value** | **Pr(>\|z\|)** |
| (Intercept) | -4.34 | 1.27 | -3.41 | 0.000643*** |
| Age | 0.48 | 0.22 | 2.19 | 0.028219* |
| Education Level | 0.31 | 0.16 | 1.89 | 0.058601. |
| Dispersion parameter for Binomial family was taken to be 1 | | | | |
| Null deviance: 107.80 on 104 df | | | AIC: 106.32 | |
| Residual deviance: 100.32 on 102 df | | Number of Fisher scoring iterations: 4 | | |

DOMESTIC CONSUMERS

All interviewees stated that they knew *E. foetidum*, and 98.94% habitually used it in their dishes. From a cultural point of view, 69.15% of the participants used it because of the influence of family tradition, 35.11% because of the indication of recipes, 5.85% because of the taste and smell, and 3.19% because of recommendations from other people.

When asked why *E. foetidum* was added to the recipes, 98.40% mentioned the flavor, 59.57% the aroma, 2.66% the color, 1.06% the texture, and 0.53% the nutrients of the plant. The main reasons for eating a meal containing *E. foetidum* were satisfaction (76.60%), happiness (19.68%), nostalgia (14.36%), regional traditions (2.66%), and a healthy diet (1.60%).

Overall, 69.95% of the respondents stated that *E. foetidum* was indispensable for everyday diet. However, 70.21% responded that they were unaware of the benefits that *E. foetidum* provides for maintaining health. Table 6 presents the purpose of use according to the part of the plant utilized, as reported by the respondents.

Table 6: Uses of the parts of *Eryngium foetidum* according to consumers.

| **Type of use** | **%** |
|---|---|
| Seasoning | 100.00 |
| Medicinal | 13.83 |
| **Part used for seasoning** | |
| Leaves | 99.47 |
| Roots | 2.13 |
| **Part used for medicinal preparations** | |
| Leaves | 11.54 |
| Roots | 92.31 |

In the comparisons of models performed for the consumer group, the best-fitted model to explain the number of dishes containing *E. foetidum* was the one that included the variable gender, with a Δi value of 0.0 (Table 7). In addition to this best-fit model, two other models were important (Table 8), in which only gender significantly affected the number of dishes containing *E. foetidum*. The results of the models showed that women use the plant in their dishes more frequently than men. Furthermore, one of the best-fitted models revealed that women also expressed more frequently than men that the plant was indispensable for their diet (Tables 9, 10), and that the age of the consumers positively influenced the knowledge about the importance of the plant for health maintenance (Tables 11, 12). None of the predictor variables significantly affected the remaining response variables.

Table **7**: Comparison of best-fitted models showing Akaike's Information Criterion (AIC) values, degrees of freedom (df), differences in AIC values (Δi), and AIC weights values, regarding the effect of socio-cultural factors on the number of dishes in which *Eryngium foetidum* is used among consumers as surveyed in street markets in the municipality of Belém, Pará, Brazil.

| **Models (predictor variables)** | **AIC** | **Δi** | **df** | **Weight** |
|---|---|---|---|---|
| Model 1: (gender) | 1049.8 | 0.0 | 3 | 0.50 |
| Model 2: (gender + age) | 1050.7 | 1.0 | 4 | 0.30 |
| Model 3: (gender + education level) | 1051.8 | 2.1 | 4 | 0.17 |
| Model 4: (null) | 1059.6 | 9.8 | 2 | 0.00 |
| Model 5: (age) | 1060.5 | 10.7 | 3 | 0.00 |
| Model 6: (education level) | 1061.6 | 11.8 | 3 | 0.00 |

Table 8: Significant models with Pr(>|z|) values regarding the effect of socio-cultural factors on the number of recipes in which *Eryngium foetidum* is used by consumers as surveyed in street markets of the municipality of Belém, Pará, Brazil.

| **Model 1 (gender)** | | | | |
|---|---|---|---|---|
| **Coefficients** | | | | |
| **Estimate** | **Std.** | **Error** | **z value** | **Pr(>\|z\|)** |
| (Intercept) | 7.14 | 0.66 | 10.67 | < 2e-16 *** |
| Gender | 2.57 | 0.74 | 3.47 | 0.00063 *** |
| Dispersion parameter for Gaussian regression was taken to be 15.25408 | | | | |
| Null deviance: 3021.7 on 187 df | | | AIC: 1049.8 | |
| Residual deviance: 2837.3 on 186 df | | | Number of Fisher scoring iterations: 2 | |
| **Model 2 (gender + age)** | | | | |
| **Coefficients** | | | | |

| Estimate | Std. | Error | z value | Pr(>\|z\|) |
|---|---|---|---|---|
| (Intercept) | 5.90 | 1.37 | 4.30 | 2.73e-05 *** |
| Gender | 2.56 | 0.74 | 3.46 | 0.000658 *** |
| Age | 0.26 | 0.25 | 1.03 | 0.302816 |
| Dispersion parameter for Gaussian regression was taken to be 15.24853 | | | | |
| Null deviance: 3021.7 on 187 df | | | AIC: 1050.7 | |
| Residual deviance: 2821.0 on 185 df | | | Number of Fisher scoring iterations: 2 | |
| **Model 3 (gender + education level)** | | | | |
| **Coefficients** | | | | |
| **Estimate** | **Std.** | **Error** | **z value** | **Pr(>\|z\|)** |
| (Intercept) | 7.20 | 0.92 | 7.75 | 5.6e-13 *** |
| Gender | 2.57 | 0.74 | 3.46 | 0.000672 *** |
| Education Level | -0.014 | 0.15 | -0.09 | 0.927578 |
| Dispersion parameter for Gaussian regression was taken to be 15.33584 | | | | |
| Null deviance: 3021.7 on 187 df | | | AIC: 1051.8 | |
| Residual deviance: 2837.1 on 185 df[1] | | | Number of Fisher scoring iterations: 2 | |

Table 9: Comparison of best-fitted models showing Akaike's Information Criterion (AIC) values, degrees of freedom (df), differences in AIC values (Δi), and AIC weights values regarding the effect of socio-cultural factors on the consumers' consideration of *E. foetidum* as indispensable for diet as surveyed in street markets in the municipality of Belém, Pará, Brazil.

| Models (predictor variables) | AIC | Δi | df | Weight |
|---|---|---|---|---|
| Model 1: (gender + education) | 222.32 | 0.0 | 3 | 0.38 |
| Model 2: (gender + age) | 222.6 | 0.3 | 3 | 0.33 |
| Model 3: (gender) | 223.23 | 0.8 | 2 | 0.25 |
| Model 4: (education) | 227.99 | 5.6 | 2 | 0.02 |
| Model 5: (age) | 228.66 | 6.3 | 2 | 0.016 |
| Model 6: (null) | 241.4 | 19 | 2 | <0.001 |

Table 10: Significant models with Pr(>|z|) values regarding the effect of socio-cultural factors on the consumers' consideration of *Eryngium foetidum* as indispensable for diet as surveyed in street markets of the municipality of Belém, Pará, Brazil.

| **Model 1 (gender + education)** | | | | |
|---|---|---|---|---|
| **Coefficients** | | | | |
| **Estimate** | **Std.** | **Error** | **z value** | **Pr(>\|z\|)** |
| (Intercept) | 0.63 | 0.51 | 1.241 | 0.21463 |
| Gender | 1.1 | 0.39 | 2.789 | 0.00529 ** |
| Education | -0.15 | 0.09 | -1.684 | 0.09217 . |
| Dispersion parameter for Binomial family was taken to be 1 | | | | |
| Null deviance: 227.26 on 187 df | | | AIC: 222.32 | |
| Residual deviance: 216.32 on 185 df | | | Number of Fisher scoring iterations: 4 | |

Table 11: Comparison of best-fitted models showing Akaike's Information Criterion (AIC) values, degrees of freedom (df), differences in AIC values (Δi), and AIC weights values regarding the effect of socio-cultural factors on the consumers' knowledge about the benefits of *Eryngium foetidum* for maintaining health as surveyed in street markets in the municipality of Belém, Pará, Brazil.

| Models (predictor variables) | AIC | Δi | df | Weight |
|---|---|---|---|---|
| Model 1: (gender + age) | 226.25 | 0.0 | 3 | 0.414 |
| Model 2: (age) | 227.35 | 1.0 | 2 | 0.247 |
| Model 3: (gender + education) | 228.14 | 1.9 | 3 | 0.161 |
| Model 4: (education) | 229.03 | 2.7 | 2 | 0.107 |
| Model 5: (gender) | 229.83 | 3.5 | 2 | 0.071 |
| Model 6: (null) | 243.4 | 17 | 2 | <0.001 |

Table 12: Significant model with Pr(>|z|) values regarding the effect of socio-cultural factors on the consumers' knowledge about the benefits of *E. foetidum* for maintaining health as surveyed in street markets in the municipality of Belém, Pará, Brazil.

| **Model 1 (gender + age)** | | | | |
|---|---|---|---|---|
| **Coefficients** | | | | |
| **Estimate** | **Std.** | **Error** | **z value** | **Pr(>\|z\|)** |
| (Intercept) | -3.2405 | 0.8844 | -3.664 | 0.000248 *** |

| | | | | |
|---|---|---|---|---|
| Gender | 0.8093 | 0.4865 | 1.663 | 0.096234 . |
| Age | 0.3567 | 0.1555 | 2.294 | 0.021783 * |
| Dispersion parameter for Binomial family was taken to be 1 | | | | |
| Null deviance: 229 on 187 df | | | AIC: 226.25 | |
| Residual deviance: 220.25 on 185 df | | | Number of Fisher scoring iterations: 4 | |

Finally, regarding the origin of the people who visited street markets to buy *E. foetidum*, a considerable number of people were from Pará (165) and few were from other states (25), with a significant difference between these proportions ($X^2 = 107.26$; $p < 0.0001$). Consumers of *E. foetidum* were mostly women, while stallholders were mostly men. There were 154 women and 34 men among consumers, and 34 women and 71 men among stallholders. The results of the chi-square test of independence were significant, indicating that proportionally more women were buying *E. foetidum* and men were selling it ($x^2 = 69.753$; $p < 0.0001$). The other results indicated that socio-cultural factors did not explain the medicinal use of the plant or its use due to family traditions. Socio-cultural factors did not significantly affect the knowledge about benefits of the plant for health maintenance.

CHEFS

Tables 13–15 present information on the answers provided by chefs on the reasons for use, innovative recipes, and use of *E. foetidum* in the preparation of recipes.

Table 13: Reasons informed by the chefs for using *Eryngium foetidum*

| **Variables** | **%** |
|---|---|
| **Reason for using *E. foetidum* in recipes** | |
| Flavor | 100 |
| Aroma | 50 |
| Texture | 12.5 |
| **What is the contribution of *E. foetidum* to the recipes** | |
| Aroma | 87.5 |
| Flavor | 62.5 |
| Cultural identity | 12.5 |
| Refreshment | 12.5 |
| Color | 12.5 |
| **Would use powdered *E. foetidum*** | |
| No | 25 |
| Yes | 75 |
| **Reason for using powdered *E. foetidum*** | |
| Alternative | 16.67 |
| Exploitation and conservation | 16.67 |
| Innovation | 33.33 |
| Practicality | 33.33 |

Table 14: Innovative recipes created by chefs using *Eryngium foetidum.*

| **Categories** | **Food** |
|---|---|
| Main course | *Pirarucu de casaca* |
| | *Mariscada paraense* |
| Side dishes | *Farofa de piracuí com banana da terra e chicória* |
| | *Pasta de chicória* |
| Desserts | *Chocolate com jambu e chicória* |
| | *Geleia de chicória* |

Table 15: Culinary uses of *Eryngium foetidum* by the chefs.

| Categories | Food | Preparation | n |
|---|---|---|---|
| Main course | Fish | *Peixe cozido* | 8 |
| | | *Peixe assado forno* | 1 |
| | | *Caldeirada de filhote* | 3 |
| | | *Caldeirada de dourada* | 4 |
| | | *Peixe ao molho de chicória* | 1 |
| | | *Dourada no tucupi* | 1 |
| | | *Filhote no tucupi* | 1 |
| | | *Peixe na chapa com crosta de chicória* | 1 |
| | Crab | *Recheio de caranguejo* | 3 |
| | | *Casquinha de caranguejo* | 2 |
| | Chicken | *Frango no tucupi* | 1 |
| | | *Galinha caipira* | 1 |
| | | *Frango guisado* | 1 |
| | Shrimp | *Camarão temperado com chicória* | 2 |
| | | *Vatapá* | 1 |
| | | *Tacacá* | 1 |
| | | *Arroz paraense* | 2 |
| | | *Moqueca Paraense* | 2 |
| | | *Camarão Cabano* | 1 |
| | Beef | *Rabada* | 1 |
| | | *Costela* | 1 |
| | Pie | *Torta de Queijo com chicória* | 1 |
| | | *Empada de chicória* | 1 |
| Side dishes | Roasted manioc flour | *Farofa de chicória* | 3 |
| | Sauce | *Molho verde de chicória* | 1 |
| | | *Molho de pimenta com chicória* | 1 |
| | Salad | *Vinagrete* | 2 |
| | Pâté | *Patê de chicória* | 1 |
| | Beans | *Feijão com chicória* | 1 |
| | Rice | *Arroz de jambú com chicória* | 1 |
| | Pasta | *Macarrão de chicória com jambú* | 1 |
| Flavoring and seasoning | | *Defumação de Peixe com chicória* | 1 |
| | | *Tucupi* | 8 |

n* number of mentions of the preparation.

Among the chefs, 100% used *E. foetidum* because of its flavor and 50% because of its aroma. When asked what the plant added to the recipes, 87.50% mentioned aroma, 62.50% flavor, 12.50% cultural identity, and 75% of the chefs said they would use the powdered form of the plant (Table 13).

The main innovative recipes mentioned by the chefs were: *pirarucu de casaca*, *mariscada paraense*, *farofa de piracuí com banana-da-terra e chicória*, *pasta de chicória*, and *chocolate com jambu e chicória*. Three recipes were pointed out as having culantro as the main ingredient: "*empada de chicória*," "*macarrão de chicória*," and "*geleia de chicória*" (Table 14). Moreover, fish-based dishes using this plant were the most frequently mentioned in the main course category, and tucupi was also mentioned in the flavoring and seasoning categories (Table 15).

## DISCUSSION

### STALLHOLDERS: DESCRIPTIVE DATA

Vegetables such as coriander, chives, and basil are sold together with *E. foetidum* since they are widely used by the population (Era et al., 2022a), mainly to season regional fish dishes from the Amazon (Dias Junior, 2019; Modesto Junior et al., 2019).

Regarding the increase in the prices of *E. foetidum*, 42% of the respondents mentioned that the value of the plant was higher during the rainy season. This may be related to the influence of rainfall on vegetable production, especially when the plant is grown in unprotected systems where they are exposed to intense rainfall, prolonging the period between planting and harvesting and thus reducing the productivity and quality of the product (Andriolo, 2020).

Another factor mentioned by the participants that affected *E. foetidum* prices was the *Círio de Nossa Senhora de Nazaré* festivities; 20% of the respondents said that the price of the plant was higher during this period. *E. foetidum* is an essential ingredient in the preparation of tucupi, an ingredient of traditional recipes consumed by locals and tourists during this religious and cultural festival (Kato et al., 2020).

### STALLHOLDERS: STATISTICAL DATA

The results of the models indicate that there was no clear profile among the stallholders as to the response variables analyzed, except for the reasons for selling the species.

What is the role of family tradition in the sale of *E. foetidum* by stallholders?

The influence of family tradition on the sale of *E. foetidum* was notably pronounced among older stallholders. This aspect becomes even clearer when associated with the the culinary and seasonal utilization of the plant. The conveyance of traditional knowledge in street markets becomes particularly evident through the routine interactions and practices of vendors specializing in medicinal and seasoning herbs. This underscores the pivotal role of cultural tradition in not only appreciating but also preserving the local socio-biodiversity (Dantas et al., 2013; Loch et al., 2020).

How do stallholders perceive the sale of *E. foetidum* in the markets?

Socio-cultural factors did not significantly influence the perceptions about *E. foetidum* sales. Stallholders had similar perceptions of the sales as good, reasonable, or bad regardless of age, education level, gender, or marketing experience. The stallholders' perception of the sales is essential to pricing vegetables according to demand and supply, especially because they are perishable foods, and the value is linked to the quality and shelf life of a product. According to Pereira et al. (Pereira et al., 2023), from the perspective of sales, it is possible to change the prices of vegetables throughout the day to reduce losses and leftovers, especially at the end of the day when stallholders want to sell their products quickly to avoid waste and possible losses.

Although markets encompass a cultural identity, the sales and purchases are fundamental for the revenue of the stallholders, making the markets therefore economically relevant for stallholders.

Which is the amount of *E. foetidum* bundles sold at the markets per week?

No relationship was found between socio-cultural factors and the number of *E. foetidum* bundles sold, as indicated by the stallholders. Men and women of different ages, education levels, and experience sold the plants as stallholders. Araujo et al., (2018) emphasized the significance of street markets as economic hubs, and that the quantity of bundles sold appeared to be intricately linked to the distinctive features of each market. Notably, there are markets commonly referred to as "supply street markets" primarily focused on the distribution of food to other provinces. This strategic focus plays a crucial role in fortifying food security within the region and, concurrently, supporting the vitality of local markets.

Are there differences between producers and middle people as suppliers?

The stallholders reported two types of suppliers of *E. foetidum*: producers and middle people. The choice of a middleperson or producer is not associated with gender, education level, age, or time working as stallholders. It is rather likely that the presence of middle people in the transport channels for the marketed vegetables influences this decision, because many producers of *E. foetidum* have difficulty selling their products at the markets due to lack of transportation and the distance between the plantations and the markets (Era et al., 2022b). Pacheco-Porto and Chuquillanque (Pacheco-Porto et al., 2021) mentioned the emergence and strengthening of people that buy from producers, sell to traders and are part of the vegetable transport circuit, given that many farmers have difficulty transporting their products. (Santos et al., 2020) observed that the presence of middle people in in markets adds value to the marketing process but also increases the prices for the end consumer. This may also influence the choice of suppliers of *E. foetidum* in Belém.

Do socio-cultural factors interfere with the perception of increase of prices at different times of the year?

Socio-cultural factors did not significantly influence the perception of the increase of prices of throughout the year. It is understandable that the perception of the increase in prices was associated with religious and cultural celebrations that took place at different times of the year. During these times, typical dishes such as *tacacá* and *pato no tucupi*, of which *E. foetidum* is an essential ingredient, are widely consumed (Ladeira et al., 2021; Macêdo et al., 2019).

Do socio-cultural factors affect the recognition of *E. foetidum* varieties by stallholders?

The stallholders recognized the existence of *E. foetidum* varieties regardless of socio-cultural factors. This demonstrates that knowledge of plant varieties is acquired through the

experience, as they handle the plants. Stallholders become familiar with plants, and gain the ability to identify the varieties (Araujo et al., 2018). In this context, Gomes et al. (Gomes et al., 2020) analyzed multicategory descriptors of *E. foetidum*, revealing the presence of several varieties and unique morphological features. Thus, we can assume that different varieties of *E. foetidum* are sold in the markets.

CONSUMERS: DESCRIPTIVE DATA

Among the interviewed consumers, 98.40% stated that flavor was the main characteristic that motivated them to use the plant, followed by aroma (59.57%). Studies have shown that aroma and flavor are attractive factors in the choice of food because the sensory nature of humans is related to taste and smell, especially when selecting food (Moura et al., 2020; Silva et al., 2021). *E. foetidum* is classified as an aromatic herb; its leaves produce an essential oil containing the chemical component *Eryngial* [(2E)-2-Dodecenal], which is responsible for the typical flavor and aroma of the plant (Quynh et al., 2012; Rodrigues et al., 2022). For this reason, it is widely used in the preparation of dishes in Belém such as *tucupi*, *tacacá*, *caruru*, and *caldeirada de peixe no tucupi*, giving originality to the recipes (Kato et al., 2020; Ladeira et al., 2021).

In this study, 69.95% of the participants reported that the plant was indispensable for their everyday diet. It was present in several common dishes, such as beans and rice, which are the basis of the Brazilian diet (Martinelli et al., 2019; Vivier et al., 2019). However, 70.21% were unaware of the benefits of the plant for maintaining health, despite *E. foetidum* being considered a nutraceutical plant that nourishes and prevents various diseases in the human body. Thus, when seasoning routine foods such as beans and rice with *E. foetidum*, meals become more nutritious, contributing to daily food quality and safety (Anju et al., 2022; Santos Filho et al., 2021).

Regarding the use of the plant, 100% of the participants used it as a condiment, and 13.83% used it for medicinal purposes. This is in line with other studies that reported the use of plants for food and medicinal purposes in Brazilian communities (Nascimento et al., 2020; Silva et al., 2020), although we observed a small proportion of consumers who used the plant for both purposes.

Most participants (99.47%) used the leaves of *E. foetidum* in their diet, whereas 92.31% used the plant, including the roots, for medicinal purposes. This may be related to the chemical constituents of the essential oils produced in the leaves and roots. The predominant chemical component in the leaves is (2E)-2-Dodecenal, responsible for the characteristic aroma and flavor of the plant, whereas in the roots, the major component is 2,3,4-trimethyl benzaldehyde,

which confers anti-inflammatory properties to the plant (Rodrigues et al., 2020; Thomas et al., 2017).

CONSUMERS: STATISTICAL DATA

Do socio-cultural factors affect the number of recipes in which *E. foetidum* is used?

None of the socio-cultural factors except gender significantly influenced the number of recipes in which *E. foetidum* was used. Women tended to use the plant more often than men. Although men are present in kitchens (Oliveira et al., 2022), reported that women are still the largest group that prepares food, and many still keep recipes from their ancestors that are used in everyday life and the family's diet.

Do socio-cultural factors explain the indication of *E. foetidum* for medicinal use?

Socio-cultural factors did not explain the indications for medicinal use. The participants used *E. foetidum* for medicinal and food purposes regardless of age, education, and gender. In this context, Silva Junior and Boscariol (Silva Junior et al., 2022) commented that local knowledge from past generations is added to the traditional uses of medicinal plants to treat diseases, Rodrigues et al. (Rodrigues et al., 2022) related the food use and the medicinal applications of *E. foetidum* to the scientifically proven bioactive properties of its leaves and roots, in addition to traditional knowledge of the efficacy of the plant in treating inflammation.

Do socio-cultural factors explain the use of *E. foetidum* motivated by family tradition?

We found no evidence that socio-cultural factors explained the use of *E. foetidum* motivated by family traditions. The use is not linked to specific socio-cultural profiles, but may involve other dimensions, such as the life history of each individual, their experiences and contact with the plant since childhood, as well as the influence of the environment and people resulting from everyday interactions. It is suggested that future research adopt more in-depth approaches to study the traditional use of the plant (Thomas et al., 2017; Silva Junior et al., 2022)

Do socio-cultural factors influence the consideration of *E. foetidum* as indispensable in the everyday diet?

Our results revealed that gender was the sole significant factor in explaining the use of the plant as indispensable in the daily diet. Women indicated the use of the plant as indispensable more frequently than men. This finding aligns with the fact that women know a greater number of recipes, as presented in the first question. None of the other socio-cultural factors explained the indication that *E. foetidum* was indispensable in daily diet. However, many participants used the plant to season beans and rice, items present in the daily diet of Brazilians, and fish, which is often present in the diet of people from Belém because of the abundance of

rivers and islands in the region, where many communities depend on fishing. Therefore, the plant is widely used to season various fish sold at markets in Belém (Nascimento et al., 2019). Do socio-cultural factors influence the knowledge about the benefits of *E. foetidum* for health maintenance?

Our results indicated that age was the only significant factor in explaining the consumers' knowledge about the benefits of *E. foetidum* for health maintenance, with older consumers mentioning the benefits more frequently. This indicates that even though older consumers may not recognize the medicinal use of the plant (second question), they acknowledge the beneficial role of the plant for health. However, although this knowledge was not related to education level or gender, it may be attributed to the popularization of the species in Belém, because the plant widely used and known in the local cuisine. Moreover, it is common knowledge that vegetables have beneficial effects on human health owing to the chemical components present in the plants (Rodrigues et al., 2022).

CHEFS: DESCRIPTIVE DATA

The chefs of regional restaurants appreciated *E. foetidum*. When asked why they used the plant in their recipes, 100% answered that they used it for its flavor, and 50% also mentioned the aroma. As mentioned earlier, eryngial (E-2 dodecenal) is the major chemical component present in the essential oil produced by the leaves of this species, which is responsible for its peculiar flavor and aroma and makes it attractive for gastronomy and providing originality to several recipes (Rodrigues et al., 2022; Stobart, 2018).

When asked about what *E. foetidum* adds to a recipe, chefs reported that, in addition to aroma and flavor, the plant adds cultural identity to the recipes. Shared regional cuisine produces cultural identity through the sense of belonging of people who are part of the same geographical region (Oliveira et al., 2021; Scherer et al., 2017).

Chefs answered that they would use powdered *E. foetidum* as a practical and innovative option. Innovation in regional gastronomy occurs through rapid changes, involving the introduction of new ingredients and techniques in recipes (Minasse et al., 2012). In addition, using edible biodiversity in menus contributes to strengthening the cultural identity, recovering and valuing eating habits, and providing nutrients beneficial to human health (Silva et al., 2021).

The chefs mentioned innovative recipes with *E. foetidum*, in which the plant was a main ingredient, such as side dishes of beans and farofa made from cassava flour, as well as desserts such as *geleia de chicória* and *chocolate com jambú e chicória*. *E. foetidum* was also identified as an indispensable for seasoning tucupi, one of the most popular dishes in the region. The plant was also mentioned as an essential ingredient in *peixe cozido* (boiled fish), a traditional family

recipe. Fish seasoned with herbs and locally produced foods are the basis of dishes and food from Pará (Dias Junior, 2019; Kato et al., 2020).

The culinary use of *E. foetidum* is an alternative for improving the food security of families because of the bioactive and antioxidant properties of this plant (Modesto Junior et al., 2019; Santos Filho et al., 2021). In Belém, *E. foetidum* is present in various recipes, whether in the main courses, side dishes, or desserts. According to Ladeira and Lima (Ladeira et al., 2021), chefs in Belém also use *E. foetidum* to prepare traditional fish recipes in a variety of ways.

## CONCLUSION

This study marks the inaugural effort to delve into the dynamics of key players in the *E. foetidum* production chain, shedding light on the attitudes of both stallholders and consumers towards a species typical of the Amazon region due to its culinary significance and widespread recognition in national markets. Contrary to expectations, socio-cultural factors were found to have minimal impact on usage and marketing practices. Although information dissemination appeared robust, the study suggests that age, educational level, and tenure as a vendor did not significantly influence food use and market strategies. Notably, the majority of *E. foetidum* vendors were older men, rooted in family traditions, while economic considerations seemed to drive the decision to sell the plant. Gender emerged as a pivotal factor influencing the frequent incorporation of *E. foetidum* in various recipes, with female consumers displaying a notable inclination towards its use in numerous dishes. Consumer behavior also highlighted the indispensable role of women, not only in recommending the plant across a variety of recipes but also in recognizing its essential contribution to the diet. Furthermore, older consumers tended to acknowledge the plant's role in maintaining health. The traditional knowledge surrounding *E. foetidum* extends beyond conventional home cuisine, presenting opportunities for diversification into innovative recipes. Despite its presence in traditional dishes, the plant has assumed a central role in novel culinary creations, hinting at untapped potential applications. However, it is crucial to acknowledge that data collection for this study was hampered by the constraints imposed by the COVID-19 pandemic, limiting the scope of the sampling used in this research.

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# 6 **DISCUSSÃO INTEGRADORA**

Nos capítulos desenvolvidos para a construção dessa pesquisa, foram apresentadas reflexões pertinentes no incremento em pesquisas de cadeias produtivas da sociobiodiversidade. É imprescindível considerar o potencial de uso de espécies nativas amazônicas, nas esferas de usos medicinais e alimentícios.

Embora o capítulo I tenha apontado um significativo potencial farmacológico da espécie, pouco se estuda sobre o manejo da planta, a fim de contribuir para a formação da cadeia produtiva. A principal contribuição da presente pesquisa é mostrar que nossos achados fortalecem os pilares para a formação da cadeia produtiva de *E. foetidum* as informações básicas, como o perfil dos produtores, e fatores que afetam o manejo e usos tradicionais com a planta, foram relatados pela primeira vez na literatura.

Diante dos argumentos, percebeu-se uma relação nas necessidades de estudos voltados para análise de fatores socioculturais que afetam a comercialização e consumo de *E. foetidum.* O trabalho apresentou como ineditismo o contexto dos comerciantes com mais idade, os quais trabalhavam com a espécie, por serem enraizados em tradições familiares, além disso, é notável que as consumidoras femininas, possuem inclinação, para a utilização da planta na culinária, aplicado em variadas recitas.

Nos três capítulos trabalhados, é perceptível a ancestralidade com algo em comum, quando se pensa na utilização da planta, bem como as mulheres são detentoras do conhecimento tradicional na utilização da espécie. Por conseguinte, este estudo contribuiu com informações para a construção da cadeia produtiva de *E. foetidum,* além de apontar possíveis gargalos a serem superados.

## 7 CONSIDERAÇÕES FINAIS

Este compêndio, é mais uma pesquisa que contribui com informações pertinentes, que apontam o amplo potencial para a formação da cadeia produtiva de *E. foetidum* na região Amazônica. Embora a espécie possua aplicação alimentícia, nossos achados demonstram que pouco se registra na literatura o uso condimentar tradicional, frente à importância dos cultivos em comunidades tradicionais agrícolas, comercialização e usos tradicionais. Assim, há campo de pesquisas, para a compreensão da identidade cultural gastronômica, envolvendo a tradição familiar com a espécie.

A pesquisa lançou luz quanto às técnicas agronômicas no cultivo de *E. foetidum*, demostrando, a fragilidade no planejamento e escalonamento, bem como na aquisição das sementes, é evidente que esses fatores podem ser um entrave quando se pensa em contribuir para a formação da cadeia produtiva da espécie. Há lacunas de estudos voltados para comercialização de sementes de *E. foetidum*, uma vez que há raros registros em literatura sobre esse tema. Além disso, não há relação dos fatores socioculturais com a utilização de adubo produzido na comunidade, opontando os gargalos para o manejo da espécie. Contudo, o fator idade indicou tendência à adoção de novas práticas de manejo do solo, com a utilização do calcário, o que sugere interesse por parte dos agricultores mais jovens em melhorar o cultivo da chicória.

Contrariamente às expectativas, descobriu-se que os fatores socioculturais tiveram impacto mínimo no uso e nas práticas de marketing. Embora a disseminação de informações parecesse robusta, o estudo sugere que idade, nível educacional e tempo de serviço como vendedor não influenciaram significativamente o uso de alimentos e as estratégias de mercado. Notavelmente, a maioria dos vendedores de *E. foetidum* eram homens mais velhos, enraizados em tradições familiares, enquanto considerações econômicas pareciam conduzir a decisão de vender a planta. O gênero surgiu como um fator fundamental que influencia a incorporação frequente de *E. foetidum* em várias receitas, com consumidoras femininas exibindo uma inclinação notável em relação ao seu uso em vários pratos.

O comportamento do consumidor também destacou o papel indispensável das mulheres, não apenas na recomendação da planta em uma variedade de receitas, mas também no reconhecimento de sua contribuição essencial para a dieta. Além disso, consumidores mais velhos tendem a reconhecer o papel da planta na manutenção da saúde. O conhecimento tradicional em torno do *E. foetidum* se estende além da culinária caseira convencional, apresentando oportunidades de diversificação em receitas inovadoras.

Apontamos que os diferentes públicos entrevistados neste estudo, formam a base da cadeia produtiva de *E. foetidum*, coligados aos elos que formam um novo panorama para os estudos fututos com a Chicória-do-Pará, em diferentes esferas, aliados às informações ao manejo tradicional e potenciais de usos, assim contribuindo para a formação da cadeia produtiva de uma espécie tão importante na amazônia.

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