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Proceeding Paper

Evaluation of the Antimicrobial Potential of Extracts from Plants of the Family Asteraceae †

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Abstract: Today, medicinal plants have multiple different uses since they can play an important role in the design of modern medicines and new healthy foods. Although their level of consumption is not high, these plants are attributed pharmacological properties with beneficial properties, such as antioxidant, anti-inflammatory, or antimicrobial, among others. This study aimed to evaluate extracts derived from *Chamaemelum nobile* and *Arnica montana*, two plants from the Asteraceae family that could be of interest for the industry, in terms of their antimicrobial capacity. After a previous bibliographic study, heat-assisted extraction (HAE) was selected and used to obtain extracts rich in bioactive compounds. Then, the antimicrobial activity was determined using three Gram-negative species, *Pseudomonas aeruginosa* (ATCC 10145), *Escherichia coli* (NCTC 9001), and *Salmonella enteritidis* (ATCC 13676), and two Gram-positive species, *Bacillus cereus* (ATCC 25923) and *Staphylococcus aureus* (ATCC 25923). The results obtained showed that *A. montana* showed a moderate antimicrobial activity with inhibition zones ranging from 6.82 to 8.36 mm while the *C. nobile* showed inhibition zones of 7.55 and 7.91 mm against *S. enteritidis* and *P. aeruginosa*, respectively. None of the plants showed activity against *S. aureus*. These results provide scientific evidence for the use of medicinal plant extracts for the development of new products with antimicrobial properties.

Keywords: medicinal plants; Asteraceae; antimicrobial activity

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1. Introduction

Since ancient times, medicinal plants have been used as a traditional treatment for various diseases or ailments. Several scientific studies have shown that these plants have different beneficial properties, such as antioxidant, anti-inflammatory, or antimicrobial among others [1]. In addition, they have been recognized as interesting matrices for the recovery of bioactive compounds, specific molecules that promote beneficial properties for health. Therefore, the content of these compounds in medicinal plants has been related to their possible health effects [2]. Northwest Spain is particularly rich in botanical and folk medicine traditions. Among the known groups, Asteraceae species (plants belonging

to the family Asteraceae) are promising candidates for their bioactive compounds and associated beneficial properties. This family of cosmopolitan distribution and easy adaptability includes 8–10% of all known angiosperms and represents 24,000–25,000 species and 1600–1700 genera [3]. In particular, two plants belonging to this family called *Chamaemelum nobile* and *Arnica montana* are the subject of this study. *Chamaemelum nobile*, commonly called Roman chamomile, is a medicinal plant that has been traditionally used to relieve fever and sunstroke, insomnia, back pain, neuralgia, rheumatism, skin conditions, or headache [4]. In addition, beneficial properties has been ascribed to these plants, such as digestive health [5], antioxidant, antibacterial, and antifungal activities [4]. Parts of the *A. montana* plant, such as flowers and root extracts, have been used in ointments for the relief of various injuries, including bruises, sprains, rheumatic pains, or inflammation. Their anticancer, antimicrobial, hepatoprotective, or antitumor bioactivities have not been still studied in great depth [6]. For this reason, the main objective of this study was to evaluate the antimicrobial capacity of *C. nobile* and *A. montana* extracts.

2. Materials and Methods

2.1. Preparation of Plants

Dry *C. nobile* and *A. montana*, were crushed until pore size was below 2 mm to obtain a fine and homogeneous powder. The parts used from each plant were the leaves, stems, and flowers.

2.2. Heat-Assisted Extraction (HAE)

HAE was applied to obtain extracts rich in bioactive compounds. To this aim, 5 g of sample was placed in a glass bottle with 100 mL of methanol–water mixture (60:40 v/v) and a magnetic stirrer. The extraction was carried out in a thermostatic bath at 45 °C for 1 h. Extracts were then freeze-dried using Telstar LyoAlfa 15, sourced in Terrassa, Spain, equipment to obtain dry extracts that were used in subsequent analyses.

2.3. Determination of Antimicrobial Activity

The antimicrobial activity was determined through plate diffusion test by measuring the inhibition zones produced by the addition of extracts.

Three Gram-negative (Gram-) species were used for this assay, *Pseudomonas aeruginosa* (ATCC 10145), *Escherichia coli* (NCTC 9001), and *Salmonella enteritidis* (ATCC 13676), and two Gram-positive species, *Bacillus cereus* (ATCC 25923) and *Staphylococcus aureus* (ATCC 25923). These bacteria were selected since they are some of the most common microorganisms causing food poisoning [7].

First, the stock cultures were inoculated into 10 mL of Mueller–Hinton Broth (MHB) and grown from 12 to 24 h at 37 °C. The evaluation of the number of colonies was performed by UV spectrometry at 600 nm and was set between 1 and 2 × 108 colony forming units (CFUs). Of the previously cultured inoculum, 100 µL were seeded and spread on a Petri dish containing Muller–Hinton agar, which was divided into four quadrants. Then, 15 µL of dimethyl sulfoxide (DMSO) was added as negative control, 15 µL of 40% lactic acid as positive control, and 15 µL of extracts (20 mg/mL in DMSO) in each of the remaining quadrants, as can be observed in Figure 1 Petri dishes were incubated for 24 h at 37 °C. After that, inhibition zones were determined [8]. Determinations were performed in triplicate and the inhibition halos were measured with a pachymeter in millimeters.

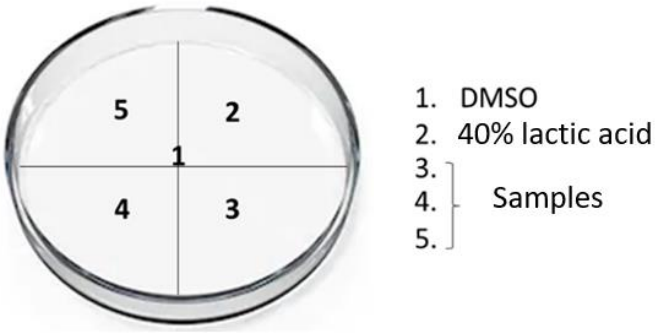


Figure 1. Distribution of different solutions and extracts in a Petri dish containing Muller–Hinton agar.

3. Results and Discussion

Table 1 shows results regarding the antimicrobial activity of the two studied plants. For this trial, the most common food-related microorganisms were selected to consider the possible use of these two plant extracts as food additives. Especially the microorganisms *S. aureus* and *S. epidermidis* are considered to cause opportunistic infections [7].

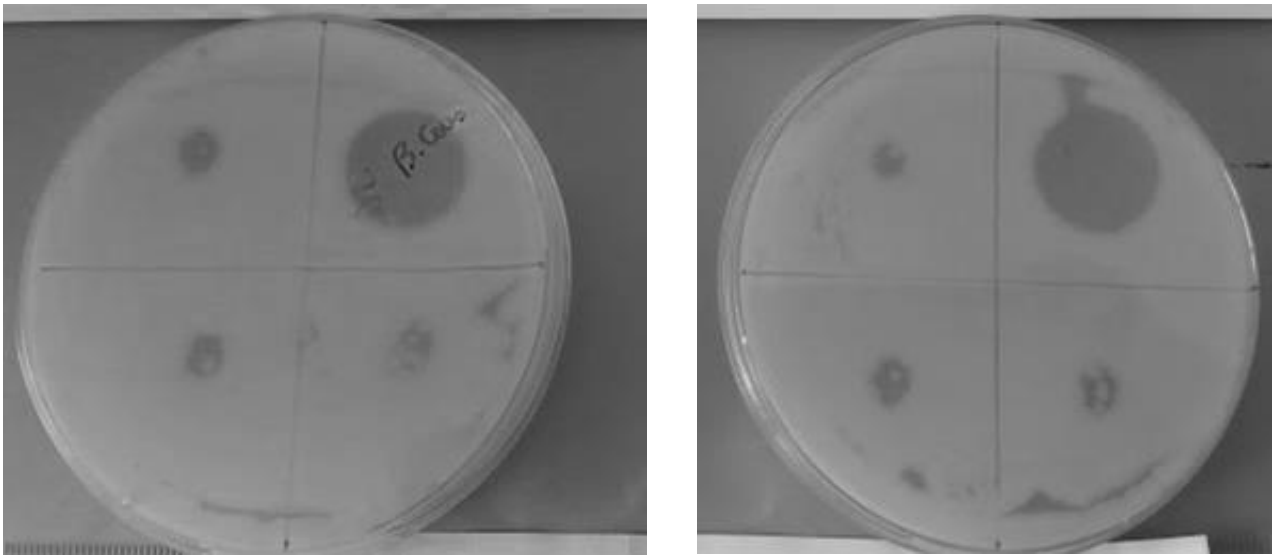
Table 1. Antimicrobial activity of *A. montana* and *C. nobile*. Bacterial growth inhibition zones diameter expressed in mm.

Plants	Gram-Negative Species			Gram-Positive Species	
	P. aeruginosa	***E. coli***	***S. enteritidis***	***S. aureus***	***B. cereus***
A.montana	6.82 ± 0.66	7.5 ± 1.47	8.36 ± 1.03	Ni*	7.73 ± 0.470
C.nobile	7.55 ± 0.54	Ni*	7.91 ± 0.83	Ni*	7.73 ± 0.46

P. aeruginosa; *Pseudomonas aeruginosa*; *E. coli*: *Escherichia coli*; *S. enteritidis*: *Salmonella enteritidis*; *S. aureus*: *Salmonella enteritidis* and *B. cereus*: *Bacillus cereus*. Ni*: no inhibition.

From Table 1, it can be observed that in both plant extracts, inhibitory effects were produced against at least one of the bacterial strains. *A. montana* showed a moderate range of antimicrobial activity (except for *S. aureus*), with inhibition halos ranging from 6.82 to 8.36 mm. Previous studies have evaluated the antimicrobial activity of selected plants. In the case of *C. nobile*, extracts rich in phenolic compounds showed inhibitory activity against *S. aureus*, *Bacillus* sp., *P. aeruginosa*, and *E. coli*, with inhibition zones ranging from 10 to 12.66 mm [9,10]. In the present study, no inhibition of *S. aureus* and *E. coli* species by *C. nobile* extracts was observed. In the case of *A. montana*, to our knowledge, no studies evaluating its antimicrobial properties have been carried out. Of the selected bacteria, *S. enteritidis* was the most affected by both plants, showing the highest ranges of inhibition (8.36 mm with *A. montana* and 7.91 mm with *C. nobile*). Figure 2 shows, as an example, the antimicrobial activity of *A. montana* and *C. nobile* against *E. coli* and *B. cereus*, respectively.

In general, differences observed in antimicrobial activity between studies may be attributed to the phytochemical composition of the studied plants, which differ according to the part used, geographic location, season, climatic conditions, etc.



(**a**) (**b**)

Figure 2. Antimicrobial activity by *C. nobile* against *B. cereus* (**a**) and by *A. montana* against *E. coli* (**b**) using plate diffusion method.

4. Conclusions

In recent years, there has been a growing interest in discovering new bioactivities from the phytochemical compounds of plants used in traditional medicine with possible industrial applications. At present, *C. nobile* and *A. montana* are used in herbal products. Both plants showed moderate antimicrobial activity against selected bacteria strains, providing scientific evidence for the potential of medicinal plant extracts in the development of new products with antimicrobial properties.

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

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