

Effects of Plant Extracts Obtained via Ultrasound-Assisted Extraction on Preventing Neonatal Diarrhoea in Calves

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Abstract

In cattle farming, neonatal diarrhoea in calves is a major challenge that frequently leads to significant morbidity and financial losses. Ultrasound-assisted extraction-derived plant extracts have become increasingly well-liked in recent years as a safe and efficient way to extract bioactive ingredients and their use in preventing diarrhoea in calves. This approach improves the extraction efficiency of phytochemicals such as polyphenols, flavonoids, and tannins, which have antibacterial, anti-inflammatory, and gut-protective activities. Studies have investigated the effectiveness of herbal extracts such as chamomile, mint, and oak bark, in reducing the incidence of diarrhoea in calves.

Keywords: calves, diarrhoea, plant extracts, Ultrasound-Assisted Extraction.

1. Introduction

Antibiotics have significantly benefited public health, food security, and safety by preventing infectious diseases in both humans and animals. However, due to their widespread use, antimicrobial resistance has increased, posing a severe danger to global health. The need for alternative measures to preserve animal health, welfare, and food security is emphasized by potential constraints on antibiotic usage in farms of cow [1,2]. Plant-derived extracts have long been known for their antibacterial properties, and phytotherapy—scientific herbal medicine that examines the molecular interactions between plant components and cells—has grown in popularity over the last two decades [3-5].

The majority of research has focused on alternatives to antibiotic growth boosters or general health enhancers, even though phytotherapy can replace standard antibiotics [6-8].

The applications of such alternatives for prevention, treatment, and metaphylaxis remain poorly defined and understudied. Additionally, there are significant differences in the availability and application of veterinary herbal medicinal medicines and feed additives among EU nations, with the main objective being prevention [2,9-10]. Plants are widely acknowledged as a promising reservoir for drug discovery, with more than 80% of contemporary pharmaceuticals originating directly from natural sources—such as plants, microorganisms, and cells—or their bioactive constituents.

A substantial number of traditional medicinal plants have been employed for the management of diarrhoea and other gastrointestinal disorders [11]. Although conventional aqueous extraction has been used for centuries, ultrasound-assisted aqueous extraction (UAE) offers significant improvements. UAE increases both the efficiency and quality of phytochemical recovery. Ultrasound waves disrupt plant tissues and enhance extraction properties. This facilitates the release of bioactive compounds [12].

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UAE is recognized as an eco-friendly, highly efficient extraction technique. It reduces or eliminates the need for organic solvents. This lowers environmental impact and increases the yield of target bioactive compounds. Ultrasonic-assisted extraction equipment (UAEE) has broadened research opportunities across chemistry, biology, pharmaceuticals, food science, and related fields [13].

Polyphenols, including phenolic acids and flavonoids, are efficiently extracted using ultrasound-assisted extraction (UAE), which generally yields higher amounts than conventional methods. However, certain compounds, such as gallic acid and catechin, can degrade under ultrasonic treatment, particularly at high power or frequency.

The degradation of catechin increases with ultrasonic frequency and input power, likely due to the generation of free hydroxyl radicals that react with and break down phenolic compounds. Therefore, preventing polyphenol degradation requires careful control of ultrasonic power [14].

Optimal UAE efficiency is typically achieved at lower frequencies, below 40 kHz, as high-frequency ultrasound can produce excessive free radicals, reducing polyphenol content and biological activity. Extraction temperature is also critical, since many phenolic compounds are

susceptible to hydrolysis and oxidation at elevated temperatures.

Proper ultrasonic conditions not only maximize polyphenol content but also enhance antioxidant activity [15,16]. Additionally, ultrasound can reduce the molecular weight of polyphenols through mechanical and shear forces, potentially improving their digestion, absorption, and bioavailability.

Studies have investigated the effectiveness of herbal extracts such as chamomile, mint, and oak bark in reducing the incidence of diarrhoea in calves.

2. Results and discussion

Concerns over antibiotic resistance and drug residues in animal-derived foods have escalated in recent years, leading to an increased concentration on phytotherapy, which employs plant-based remedies as alternative or complementary therapeutic modalities.

Among the most promising natural preparations are the aqueous extracts of chamomile (*Matricaria chamomilla*), peppermint (*Mentha piperita*), and oak bark (*Quercus robur*), which have been reported to exhibit anti-inflammatory, antibacterial, astringent, and antispasmodic properties (Figure 1).



Figure 1. Ultrasound-assisted extraction of bioactive compounds from chamomile, mint and oak for potential use in preventing neonatal diarrhoea in calves

Chamomile (*matricaria recutita* L.) is well-known and recorded in scientific medicinal literature and ethnoveterinary surveys from Switzerland, Austria, southern Italy, and western Spain [17-20]. Chamomile flowers are primarily composed of sesquiterpene-containing essential oil and flavones [21].

Chamomile flowers are traditionally used as a decoction or infusion to treat bovine digestive issues, particularly diarrhoea [22,23]. Depending on the strength and technique of preparation, chamomile tea or decoction is used to treat various digestive issues in cattle. Farmers in the Bilogora region treated cattle dyspepsia (without diarrhoea) with light chamomile tea.

The chamomile flowers were filtered, and 5–10 L of warm tea was given orally. They frequently added 1-2 tablespoons of baking soda and 0.25-0.5 kilograms of bakery yeast to heated tea. Farmers made a decoction of larger amounts of chamomile flowers, aerials, and cooked them in a metal boiler with 25–50 L of water until some of the water evaporated. After cooling, filter the decoction using a sieve and administer 10–15 L orally. This process was repeated every two to three days [24]. El-Kholany et al. [25] found that adding chamomile at levels of 0, 5, and 10 g/100 kg BW/day to calves' diets gradually increased the digestibility coefficients of all nutrients as well as the total feeding value.

Quercus (*oak*) extracts are a rich source of bioactive compounds, particularly polyphenols

and tannins, which exhibit a range of pharmacological properties [26].

Polyphenolic substances, such as ellagitannins, gallic acid, protocatechuic acid, catechin, and others, are abundant in oak bark, particularly the hydrolysable and condensed tannins. It has been shown that these substances have astringent, antibacterial, antimicrobial, antioxidant, and anti-inflammatory properties. Additionally, new research on enhanced extraction techniques, including loop-ultrasound reactors and ultrasound-assisted extraction (UAE), suggests that yields of tannin and polyphenols are significantly higher [27].

Mint (*mentha piperita*) - in a related study, Raj Ritu et al. [28] incorporated 4% mint into the concentrate feed of weaned calves. They concluded that mint supplementation enhanced appetite and improved feed acceptability, without necessitating combination with supplements.

It has been demonstrated that adding herbal or phytobiotic feed additives - which occasionally contain mint or substances derived from mint - can reduce the prevalence of diarrhoea in calves.

Jahani-Azizabadi et al. [29] reported that giving calves a blend of herbal extracts rich in phytochemicals reduced the incidence of diarrhoea when compared to the control group.

Table 1 presents bioactive compounds from chamomile, mint, and oak bark and their effects on neonatal diarrhoea in calves.

Table 1. Bioactive compounds from chamomile, mint, and oak bark and their effects on neonatal diarrhea in calves

Plants	Key bioactive compounds	Biological properties of the extract	Effects on neonatal diarrhea in calves
Chamomile (<i>Matricaria chamomilla</i>)	Apigenin, Bisabolol, Flavonoids	Anti-inflammatory, Antispasmodic, Antibacterial	Reduces intestinal inflammation; Relieves gastrointestinal spasms; Decreases severity and duration of diarrhoea.
Mint (<i>Mentha piperita</i>)	Menthol, Rosmarinic acid, Polyphenols	Antibacterial, Antispasmodic, Antioxidant	Inhibits enteric pathogens; Reduces intestinal hypermotility; Shortens the course of diarrhoea episodes.
Oak bark (<i>Quercus robur</i>)	Condensed tannins, Polyphenols	Astringent, Antimicrobial, Intestinal mucosa protector	Forms a protective layer on intestinal mucosa; Reduces excessive fluid secretion; Lowers diarrhoea incidence and supports gut recovery.

3. Conclusions

The use of medicinal herbs, together with innovative extraction techniques such as ultrasound-assisted

aqueous extraction, provides a sustainable and effective solution for improving gastrointestinal health in livestock.

Phytotherapy, which employs herbs like chamomile, mint, and oak bark for their antibacterial, anti-inflammatory, and protective properties, may help reduce reliance on antibiotics in cattle farming. When combined with proper nutrition, hygiene, and housing, phytotherapy supports an integrated and long-term approach to animal health management.

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