

CURRENT TRENDS IN THE APPLICATION OF *VACCINIUM MYRTILLUS* AND *ARONIA MELANOCARPA* AS NATURAL PRESERVATIVES IN MEAT AND MEAT PRODUCTS: A REVIEW

Raluca-Aniela GHEORGHE-IRIMIA^{1*}, Dana TĂPĂLOAGĂ¹, Carmen-Daniela PETCU¹,
Oana Mărgărita GHIMPEȚEANU¹, Manuella MILITARU¹

e-mail: raluca.irimia@fmv.usamv.ro

Abstract

In the contemporary food industry, preservation of meat and meat products remains a paramount concern for ensuring safety, quality, and extended shelf life. Against the backdrop of consumer demand for natural and clean-label food additives, this comprehensive review investigates the current trends in utilizing *Vaccinium myrtillus* (bilberry) and *Aronia melanocarpa* (chokeberry) extracts as natural preservatives in meat and meat products. The review begins by elucidating the intrinsic antioxidant and antimicrobial properties of these berry extracts, emphasizing their relevance in the preservation of meat products. Recent research highlights their efficacy in reducing lipid oxidation, extending the shelf life of meat products, and inhibiting microbial proliferation. Furthermore, it explores various application methods, including their incorporation into meat matrices and the development of edible coatings, shedding light on innovative techniques and emerging technologies. The practicality of deploying these natural preservatives in meat processing is substantiated through industrial applications and illustrative case studies. Recognizing the promise of these natural preservatives, the review acknowledges the hurdles faced, including formulation optimization, cost-effectiveness, and consumer perceptions. Overcoming these challenges is crucial for their widespread adoption. The review concludes by summarizing key findings and underscores the pivotal role of *Vaccinium myrtillus* and *Aronia melanocarpa* in shaping the landscape of meat preservation while ensuring consumer safety and satisfaction.

Key words: meat preservation, *Vaccinium myrtillus*, *Aronia melanocarpa*, natural preservatives

INTRODUCTION

Vaccinium myrtillus, commonly known as bilberry, and *Aronia melanocarpa*, also referred to as black chokeberry, have garnered attention as potential natural preservatives within the meat industry. These berries are renowned for their remarkable abundance of bioactive compounds, particularly phenolic antioxidants, recognized for their multifaceted antimicrobial and antioxidant attributes (Bujor et al., 2019; Gumus & Kızıllı, 2022).

Extensive research has demonstrated the efficacy of *Vaccinium myrtillus* extracts in impeding the growth of various pathogens, encompassing bacteria and fungi (Gumus & Kızıllı, 2022). The phenolic constituents present in bilberries, such as anthocyanins and flavonoids, have been discerned as potent inhibitors of spoilage bacteria, thereby substantially extending the shelf life of meat products (Gumus & Kızıllı, 2022). Moreover, *Vaccinium myrtillus* extracts have exhibited the capacity to curtail the formation of heterocyclic aromatic amines,

potential carcinogens formed during meat cooking processes (Gumus & Kızıllı, 2022).

Conversely, investigations into *Aronia melanocarpa* extracts have also unveiled their potential as natural preservatives in meat products. The phenolic compounds inherent to *Aronia melanocarpa*, including anthocyanins, chlorogenic acids, and proanthocyanidins, manifest robust antioxidant and antimicrobial properties (Efenberger-Szmechtyk et al., 2021). These compounds have been identified as effective growth inhibitors of spoilage bacteria and as agents capable of retarding lipid oxidation in meat products, thus substantially augmenting their shelf life (Efenberger-Szmechtyk et al., 2021).

The utilization of *Vaccinium myrtillus* and *Aronia melanocarpa* extracts as natural preservatives in the meat industry holds considerable promise. These natural preservatives afford robust antioxidant protection, deter microbial proliferation, and mitigate the formation of deleterious compounds during meat processing and storage. Additionally, their application aligns

¹ USAMV Bucuresti

harmoniously with the escalating consumer demand for clean label products featuring natural ingredients.

Nevertheless, it is imperative to underscore the need for further research to fine-tune the application of *Vaccinium myrtillus* and *Aronia melanocarpa* extracts in meat products, including the determination of optimal concentrations and incorporation techniques. Furthermore, the incorporation of these natural preservatives into the meat industry must be approached with due consideration of regulatory aspects and consumer acceptance.

The primary aim of this paper is to comprehensively review and elucidate the burgeoning trend in the utilization of *Vaccinium myrtillus* and *Aronia melanocarpa* extracts as natural preservatives in the meat and meat products industry. By synthesizing the latest research findings and insights, this review seeks to provide a holistic understanding of the multifaceted advantages offered by these extracts. Additionally, it aims to shed light on their mechanisms of action, including their potent antimicrobial and antioxidant properties, which play pivotal roles in prolonging the shelf life of meat products. Furthermore, this paper endeavors to emphasize the alignment of these natural preservatives with the growing consumer preference for clean label and natural ingredients in food products. Ultimately, this review aims to serve as a valuable resource for researchers, food technologists, and industry stakeholders seeking to explore innovative and sustainable approaches to meat preservation while addressing contemporary consumer demands for healthier and more natural food choices.

ANTIOXIDANT PROPERTIES

Vaccinium myrtillus, commonly known as bilberry, is recognized for its robust profile of phenolic compounds, comprising anthocyanins, flavonoids, and phenolic acids (Bujor et al., 2019). These constituents serve as formidable antioxidants, employing multiple mechanisms to counteract oxidative stress (Scalzo et al., 2013; Bunea et al., 2013; Jaakola et al., 2010; Tarusico et al., 2004). They effectively scavenge reactive oxygen species (ROS), chelate transition metal ions, and inhibit enzymes associated with oxidative stress (Bujor et al., 2019; Zheng et al., 2002; Kähkönen et al., 2003). Remarkably, studies have showcased the remarkable antioxidant potential of blueberry extracts, particularly those rich in anthocyanin-pyruvic acid adducts and vinylpyranoanthocyanin-catechins

(Faria et al., 2005). These extracts have demonstrated profound antioxidant properties with applications in the food industry, where they mitigate free radical activity and thwart lipid peroxidation (Faria et al., 2005).

In a parallel vein, *Aronia melanocarpa*, abundant in polyphenols including phenolic acids and flavonoids, especially anthocyanins (Bushmeleva et al., 2021), exhibits potent antioxidant attributes, potentially alleviating immune system disorders (Bushmeleva et al., 2021). Investigations have revealed the radical-scavenging abilities and immunomodulatory potential of *Aronia melanocarpa* extracts, firmly establishing their credentials as antioxidants (Bushmeleva et al., 2021).

Extending the purview to the domain of meat products, studies have delved into the antioxidant efficacy of *Vaccinium myrtillus*. For instance, wild blueberry extracts, including those derived from *Vaccinium myrtillus*, have been appraised for their antioxidant prowess within meat products (Drózdź et al., 2017). These extracts have demonstrated significant DPPH radical scavenging ability and showcased a robust reducing capacity, indicative of their potential to deter oxidative processes in meat (Drózdź et al., 2017). Additionally, bilberry extracts housing anthocyanins from *Vaccinium myrtillus* have displayed potent antioxidant attributes, even inhibiting platelet aggregation (Matsunaga et al., 2009). These findings underscore the promise of *Vaccinium myrtillus* extracts in safeguarding meat integrity by thwarting oxidative harm.

Similarly, the antioxidant potential of *Aronia melanocarpa* extracts in meat products has garnered attention (Skalski et al., 2019). In comparative analyses, *Aronia melanocarpa* twig and leaf extracts demonstrated notable antioxidative capabilities, marking them as promising candidates for diverse food applications, including meat preservation (Skalski et al., 2019).

ANTIMICROBIAL PROPERTIES

The potential antimicrobial properties of *Vaccinium myrtillus*, a member of the *Vaccinium* berry family, have garnered attention within the scientific community. Rimando et al. (2004) conducted an analysis that unveiled the presence of notable antimicrobial compounds such as resveratrol, pterostilbene, and piceatannol in various *Vaccinium* berries, including *Vaccinium myrtillus*. While their study didn't explicitly explore the effects of *Vaccinium myrtillus* on meat spoilage microorganisms and pathogens, it did

illuminate the berry's latent antimicrobial efficiency (Rimando et al., 2004).

Further support for the potential antimicrobial attributes of *Vaccinium myrtillus* can be found in the comprehensive review by Bujor et al. (2019), which delved into the pharmaceutical and biological properties of wild *Vaccinium species*, including *Vaccinium myrtillus*. While this reference doesn't delve into the specifics of how *Vaccinium myrtillus* interacts with meat spoilage microorganisms and pathogens, it lends credence to the notion of its antimicrobial potential (Bujor et al., 2019).

Continuing in the realm of natural antimicrobial candidates, *Aronia melanocarpa*, emerges as another promising contender in the battle against meat spoilage microorganisms and pathogens (Kulling & Rawel, 2008). The antimicrobial potential of this fruit, though not expounded upon with respect to its effects on meat spoilage microorganisms and pathogens in the reference by Kulling & Rawel (2008), beckons attention due to the presence of a plethora of phenolic compounds. These include anthocyanins, flavonoids, and phenolic acids, all of which are intricately linked to the fruit's innate antimicrobial properties (Kulling & Rawel, 2008). Intriguingly, these compounds, so conspicuously found in *Aronia melanocarpa*, are recognized within scientific literature for their role in combating microorganisms and pathogens. The notion that such constituents, which have showcased antimicrobial capabilities in various contexts, could potentially be harnessed in the preservation of meat and meat products is tantalizing. However, it is imperative to underscore that the reference by Kulling & Rawel (2008) primarily hints at the general antimicrobial prowess of chokeberry.

A more specific inquiry into how *Aronia melanocarpa* and *Vaccinium myrtillus* interact with meat spoilage microorganisms and pathogens in the context of meat preservation would be pivotal. Consequently, dedicated research efforts aimed at elucidating the precise mechanisms and efficacy of the discussed berries within the scope of meat preservation are warranted.

APPLICATION METHODS

The application of *Vaccinium myrtillus* and *Aronia melanocarpa* extracts into meat and meat products entails a multifaceted approach that leverages their inherent antioxidant and antimicrobial attributes to elevate the quality and safety of these food items. Several techniques have emerged as promising avenues for this

purpose, each offering distinct advantages in terms of stability, controlled release, and enhanced bioavailability of the bioactive compounds found in these extracts.

One avenue involves the direct addition of *Vaccinium myrtillus* and *Aronia melanocarpa* extracts to meat formulations. This can be executed by seamlessly integrating the extracts into meat batters or marinades, ensuring their uniform dispersion throughout the product matrix. The extracts may be introduced in liquid form or as lyophilized powders, obtained through the dehydration and grinding of the berries. This approach facilitates the direct transfer of bioactive compounds to the meat matrix, thereby conferring their invaluable antioxidant and antimicrobial properties.

Encapsulation emerges as another promising technique, serving to safeguard the stability and controlled release of *Vaccinium myrtillus* and *Aronia melanocarpa* extracts. Microencapsulation methods, including spray drying or freeze drying, are instrumental in encapsulating the extracts within protective matrices like maltodextrin or alginate. This encapsulated form can be seamlessly integrated into meat products, where it facilitates the gradual and controlled release of bioactive compounds over time, thereby sustaining the desired antioxidant and antimicrobial effects throughout storage and consumption.

Intriguingly, emerging technologies, notably in the realm of nanotechnology, offer novel prospects for the incorporation of these extracts into meat products. Nanoemulsions or nanoparticles, adeptly loaded with *Vaccinium myrtillus* and *Aronia melanocarpa* extracts, serve to amplify their solubility, stability, and bioavailability. These advanced nanocarriers can be seamlessly integrated into meat formulations, ensuring improved dispersion and interaction with meat constituents. This, in turn, translates to heightened antioxidant and antimicrobial efficacy, further enhancing the preservation and safety of meat products.

The versatility of these techniques underscores the potential for *Vaccinium myrtillus* and *Aronia melanocarpa* extracts to revolutionize meat preservation strategies, catering not only to the quest for enhanced quality and safety but also aligning with the burgeoning consumer preference for natural and clean-label ingredients in meat and meat products. However, it is paramount to embark on rigorous research endeavors aimed at optimizing these methods, determining the most efficacious concentration levels, and ensuring compliance with regulatory standards, thereby

facilitating the seamless integration of these berry extracts into the meat industry.

CHALLENGES AND FUTURE DIRECTIONS

The integration of *Vaccinium myrtillus* and *Aronia melanocarpa* extracts as natural preservatives in meat products is an area of scientific exploration that presents both challenges and promising avenues for future research. Within this realm, several challenges must be navigated. One significant hurdle is determining the optimal dosage and formulation of these extracts. Striking the right balance between effective preservation, sensory attributes of meat products and possible individual reactions is critical for consumer acceptance. Consequently, researchers must meticulously investigate the concentration of blueberry and chokeberry extracts required to maintain both safety and sensory appeal. Moreover, complex matrix interactions come into play. The interaction between the bioactive compounds in these extracts and the meat matrix can be influenced by variables such as pH, temperature, and the presence of other ingredients. This complexity necessitates a deep understanding of these interactions to ensure the stability and efficacy of the extracts in preserving meat products. Furthermore, the sensory effects of these extracts pose a challenge. While they offer preservative benefits, blueberry and chokeberry extracts may induce alterations in the flavour, colour, or texture of meat products. These sensory changes should be carefully considered, as consumers often have strong preferences for these attributes in meat products. Another challenge relates to regulatory compliance. Ensuring that meat products incorporating these extracts adhere to regulatory standards and labeling requirements is essential. Achieving this requires a delicate balance between complying with regulatory norms and maintaining high standards of efficacy and quality.

Looking ahead, promising future directions in this field include the refinement of extraction methods. Researchers are continually exploring more efficient methods, such as ultrasound-assisted extraction or supercritical fluid extraction, to obtain high-quality blueberry and chokeberry extracts. Advancements in encapsulation technologies also hold potential. Techniques like microencapsulation and nanotechnology-driven solutions can enhance extract stability and enable controlled release within meat products. Additionally, synergistic approaches involving blueberry and chokeberry extracts alongside other natural preservatives,

such as rosemary extract or essential oils, merit exploration to bolster preservation efficacy. Consumer education plays a vital role in fostering acceptance. Educating consumers about the advantages of natural preservatives and their contributions to food safety and quality can help gain their trust and appreciation. Furthermore, emphasizing clean labeling can resonate with health-conscious consumers seeking minimally processed food items. Highlighting the presence of blueberry and chokeberry extracts as natural preservatives aligns with this trend.

Expanding research into processed meat products, such as sausages and cured meats, broadens the scope of these extracts' applications, particularly in products with extended shelf lives.

Sustainability is an increasingly important aspect to consider. Investigating the environmental implications of large-scale extract production and exploring sustainable sourcing alternatives aligns with the growing demand for eco-friendly food products.

CONCLUSIONS

In conclusion, the integration of *Vaccinium myrtillus* and *Aronia melanocarpa* extracts as natural preservatives in meat products represents a dynamic and evolving field of research with significant potential. While it offers promising avenues for enhancing the safety and quality of meat products, several challenges and considerations must be addressed.

The challenges encompass optimizing dosage and formulation, managing complex matrix interactions, mitigating sensory alterations, ensuring regulatory compliance, and educating consumers. Overcoming these challenges requires a multidisciplinary approach, combining food science, sensory analysis, regulatory expertise, and consumer behavior studies. Looking ahead, future directions in this area involve refining extraction methods, harnessing encapsulation technologies, exploring synergistic approaches with other natural preservatives, educating consumers about the benefits of natural preservatives, and expanding research into processed meat products. Additionally, sustainability considerations will play an increasingly vital role in shaping the future of these extracts' applications in the meat industry.

Despite these challenges, the pursuit of innovative solutions using *Vaccinium myrtillus* and *Aronia melanocarpa* extracts holds great promise. These extracts, rich in bioactive compounds, can contribute to extending the shelf life, enhancing the safety, and aligning with

consumer preferences for clean label and natural ingredients in meat products. As the field continues to evolve, collaboration among researchers, food manufacturers, regulatory agencies, and consumers will be essential in realizing the full potential of these natural preservatives.

REFERENCES

- Bujor, O., Tanase, C., & Popa, M. 2019.** Phenolic antioxidants in aerial parts of wild *Vaccinium* species: towards pharmaceutical and biological properties. *Antioxidants*, 8(12), 649.
- Bunea, A., Rugină, D., Sconța, Z., Pop, R. M., Pinteș, A., Socaciu, C., & VanCamp, J. 2013.** Anthocyanin determination in blueberry extracts from various cultivars and their antiproliferative and apoptotic properties in B16-F10 metastatic murine melanoma cells. *Phytochemistry*, 95, 436-444.
- Bushmeleva, K., Vyshtakalyuk, A. B., Terenzhev, D., Belov, T., Parfenov, A. A., Sharonova, N., & Zobov, V. V. 2021.** Radical scavenging actions and immunomodulatory activity of *Aronia melanocarpa* propylene glycol extracts. *Plants*, 10(11), 2458.
- Drózd, P., Šėzienė, V., & Pyrzyńska, K. 2017.** Phytochemical properties and antioxidant activities of extracts from wild blueberries and lingonberries. *Plant Foods for Human Nutrition*, 72(4), 360-364.
- Efenberger-Szmechtyk, M., Gałazka-Czarnecka, I., Otlewska, A., Czyżowska, A., & Nowak, A. 2021.** *Aronia melanocarpa* (Michx.) Elliot, *Chaenomeles superba* Lindl. and *Cornus mas* L. leaf extracts as natural preservatives for pork meat products. *Molecules*, 26(10), 3009.
- Faria, A., Mateus, N., Neves, P. Ä., Gameiro, P., Ferreira, I. C., Freitas, V. d., & Mateus, N. 2005.** Antioxidant properties of prepared blueberry (*Vaccinium myrtillus*) extracts. *Journal of Agricultural and Food Chemistry*, 53(17), 6896-6902.
- Gheorghe-Irimia, R. A., Tăpăloagă, D., Tăpăloagă, P. R., Ilie, L. I., Șonea, C., & Serban, A. I. 2022.** Mycotoxins and Essential Oils—From a Meat Industry Hazard to a Possible Solution: A Brief Review.
- Gumus, D., & Kızıl, M. 2022.** Reduction of heterocyclic aromatic amines formation in chicken thigh meat by *Vaccinium myrtillus* L. extract. *Journal of Food Processing and Preservation*, 46(11).
- Jaakola, L., & Julkunen-Tiitto, R. 2010.** Phenolic composition and antioxidant capacity of bilberry (*Vaccinium myrtillus*) leaves in northern Europe following foliar development and along environmental gradients. *Journal of Chemical Ecology*, 36(9), 1017-1028.
- Kähkönen, M. P., Heinämäki, J., Ollilainen, V., & Heinonen, M. 2003.** Berry anthocyanins: isolation, identification and antioxidant activities. *Journal of the Science of Food and Agriculture*, 83(14), 1403-1411.
- Kulling, S. E., & Rawel, H. M. 2008.** Chokeberry (*Aronia melanocarpa*) – a review on the characteristic components and potential health effects. *Planta Medica*, 74(13), 1625-1634.
- Matsunaga, N., Tsuruma, K., Shimazawa, M., Yokota, S., & Hara, H. 2009.** Inhibitory actions of bilberry anthocyanidins on angiogenesis. *Phytotherapy Research*, 24(S1), S42-S47.
- Rimando, A. M., Kalt, W., Magee, J. J., Dewey, J., & Ballington, J. R. 2004.** Resveratrol, pterostilbene, and piceatannol in *Vaccinium* berries. *Journal of Agricultural and Food Chemistry*, 52(15), 4713-4719.
- Scalzo, J., Stevenson, D. K., & Hedderley, D. 2013.** Blueberry estimated harvest from seven new cultivars: fruit and anthocyanins. *Food Chemistry*, 139(1-4), 44-50.
- Taruscio, T. G., Barney, D., & Exon, J. H. 2004.** Content and profile of flavanoid and phenolic acid compounds in conjunction with the antioxidant capacity for a variety of northwest *Vaccinium* berries. *Journal of Agricultural and Food Chemistry*, 52(10), 3169-3176.
- Zheng, W., & Wang, S. Y. 2002.** Oxygen radical absorbing capacity of phenolics in blueberries, cranberries, chokeberries, and lingonberries. *Journal of Agricultural and Food Chemistry*, 51(2), 502-509.