Exploring the Benefits of Animal Antioxidants for Optimal Health

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Abstract
An essential component of human nutrition and health is the study of animal-based proteins, which provide a plentiful source of vital nutrients for physiological functions as well as general wellness. These proteins provide the complete amino acid profile required for the synthesis and maintenance of tissues, enzymes, hormones, and immunological components. They can be derived from a variety of animal sources, including meat, chicken, fish, eggs, and dairy products. Throughout human history, animal proteins have been an integral part of diets, greatly influencing gourmet diversity, cultural traditions, and nutritional sufficiency. We now have a better grasp of the nutritional makeup and functional properties of animal proteins because to developments in food science and technology. This has created space for creative

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1. Introduction

Animal-based antioxidants are essential components of a balanced diet. These antioxidants are sourced from various animal-derived foods, each offering unique benefits. Incorporating a variety of animal-based antioxidants into your diet can provide a range of health benefits, from bolstering your immune system to protecting against chronic diseases and supporting overall vitality. Oxidative stress, primarily caused by an imbalance between the production and neutralization of prooxidants, is linked to a number of contemporary non-communicable diseases (Ayoka, et al., 2022). Antioxidants can be found in abundance in food proteins (Wafula et al., 2017). These substances, which might be manufactured or natural, act as antioxidants by delaying or blocking the oxidation process at comparatively low concentrations. According to Tsoukalas et al. (2021) they can be separated into primary and secondary compounds. Natural antioxidants such vitamin C, carotenoids, anthocyanins, and phenols found in a variety of animal-based diets may interact with free radicals before causing harm to the host cells (Camps, et al., 2014).

Humans can be protected against cancer and a wide range of other diseases, such as inflammatory and cardiovascular conditions, by phenolic chemicals found in animal diets (Gallegos et al., 2024). According to Ahmad et al. (2023), vitamin C is a common natural antioxidant that lowers blood uric acid levels and lowers the risk of stroke, chronic illnesses, and degenerative disorders. Another antioxidant that shields the cell membrane, stops lipid peroxidation, and chelates reactive oxygen species (ROS) is vitamin E (tocopherol). Lycopene, lutein, zeaxanthin, and carotenoids lower the risk of metabolic disorders and cancer. Flavones have anti-inflammatory properties in addition to being antioxidants (Dama et al., 2024). These naturally occurring antioxidants have minimal toxicity, high availability, and are used as anticancer agents in many traditional cuisines and indigenous remedies. According to Xia et al. (2023), combining these substances with food ingredients can have cytotoxic effects on cancer cells and cytoprotective benefits on normal cells. Antimicrobial compounds, such as natural antioxidants, can be employed to manage foodborne infections, including Salmonella.

Antioxidants from Animal Sources

2.1 Fish: Fish is a major source, especially fatty fish that are high in omega-3 fatty acids like docosahexaenoic acid (DHA) and eicosatetraenoic acid (EPA), such as salmon, mackerel, and trout. These omega-3s help other antioxidants be absorbed in addition to having antioxidant qualities of their own. (Sethi et al., 2014).

2.2 Egg White Proteins: Phosvitins and ovotransferrins, which are present in egg whites, are examples of potential antioxidant proteins (Mavrommatis, et al., 2023). The principal antioxidant function of these proteins is to chelate ionic irons, thereby inhibiting lipid oxidation that is mediated by metals (Bešlo, et al., 2023). Specifically, upon binding to metal ions, ovotransferrin has a prominent thiol-linked self-cleavage activity (Petcu, et al., 2023). Many peptides produced from proteins through various physicochemical mechanisms or enzymatic hydrolysis have demonstrated antioxidative qualities. The length, composition, and amino acid sequence of these peptides all influence how effective they are as antioxidants (Cretton et al., 2023). The building blocks of these antioxidant peptides are the proteins that can be found in dairy products, shellfish, eggs, meat, and animal by-products such as skin, fins, stomach, and blood. Petcu et al. (2023) state that bioactive peptides are produced from a wide variety of proteins and possess characteristics that are exclusive to their physiological effects. The therapeutic application of bioactive peptides is particularly prevalent in traditional medicine, which makes considerable use of these molecules. Eggs from chicken are considered to be one of the best sources of bioactive peptides, many of which have positive effects on health (Piao et al., 2023). It was the proteases chymotrypsin, trypsin, and pepsin that were

responsible for the creation of the egg protein peptides that contain antioxidants. In order to produce antioxidant peptides, the processing of egg white proteins requires the utilization of ovotransferrin, lysozyme, ovalbumin, ovomucin, and ovomucoid (Xiang et al., 2023). According to Tuong et al.'s 2023 research, ovalalbumin peptides that included protease and pepsin, in addition to ovaltransferrin peptides (WNIP, GWNI, IRW, and LKP), had a powerful antioxidant function. Strong antioxidant characteristics are possessed by peptides that are generated from other egg white proteins, ovomucin and ovomucoid, with the application of heat at a high pH or through enzymatic hydrolysis (Aldian et al., 2023). In addition to inhibiting oxidation, the peptides found in egg white proteins chelated Fe^{2+} and Cu^{2+}. In a different study (Alara et al., 2023), a variety of enzymes hydrolyzed egg white proteins, which resulted in the generation of antioxidant-active peptides. These peptides include VYLPR, YLGAK, GGLEPINFN, ESKPV, DVYSF, and DSTRTQ. According to Avila-Nava et

al.'s 2023 research, pepsin and pancreatin degraded yolk proteins, which resulted in the production of WYGPD and KLSDW peptides that possessed antioxidant activity comparable to that of synthetic antioxidants. In accordance with the findings of Surai et al. (2023), the peptides LMSYMWSTSM, LELHKLRSSHWFSRR, and LELHKLRSSHWFSRR that are generated from yolk phosvitin have demonstrated powerful antioxidant activities. Several antioxidant assays, such as the DPPH radical scavenging assay, were utilized to establish the presence of antioxidant activity in the following samples: WYGPD, KLSDW, KGLWE, YINQMPQKSRE, YINQMPQKSREA, VTGRFAGHPAAQ, LMSYMWSTSM, LELHKLRSSHWFSRR, RASDPLLSV, RNDDLNYIQ, LAPSLPGKPKPD, and AGTTCLFTPLALPYDYSH.QSLVSVPGMS, YIEAVNKVSPRAGQF, and a few other examples. To quote Lugata et al. (2023)**Table1: Animal based antioxidant and their sources**

Antioxidants	Food Sources
Omega-3 Fatty Acids	Fatty fish (salmon, mackerel, trout)
Vitamin A	Liver, eggs
Vitamin E	Liver, eggs, dairy products
Vitamin C	Liver, eggs
Selenium	Organ meats (liver), dairy products
Zinc	Organ meats (liver), dairy products

2.3 Milk and Milk products: Cheese, yogurt, and other dairy products contain vitamins A, E, zinc, and selenium. Processing, notably fermentation, produces animal bioactive peptides (Wang et al., 2023). In fermentation, proteins break down into polypeptides and microbial enzymes into smaller peptides (Bień, et al., 2023). Many exopeptidase enzymes can split polypeptides' N or C terminals into dipeptides, tripeptides, or single amino acids, which can be antioxidant bioactive molecules. Milk and products like whey are good sources of proteins for bioactive peptides and were the first animal protein sources used to make antioxidant peptides (Abd El-Hack, et al., 2023). Two endogenous protease enzymes break down milk proteins and create antioxidant-active peptides with an amino acid sequence of VLPVPQK (Imchen et al., 2023). Several antioxidant peptides are in sheep milk. Bacillus spp. produced peptides from αs1- and αs2 casein (Zare, et al., 2023).
Pepsin, papain, and alcalase hydrolyzed camel milk to create peptides with the amino acid sequences of RLDGQGRPRVWLGR, TPDNIDIWLGGIAEPQVKR, and VAYSDDGENWTEYRDQGAVEGK, which had strong antioxidant properties (Tian, et al., 2023). Hydrolysis of buffalo milk casein with pepsin, trypsin, and chymotrypsin produced bioactive peptides with the amino acid sequence VLPVPQK that had high antioxidant activity (Dalaka et al., 2023). Jairath et al. (2023) found that hydrolysis of bovine and ovine milk proteins yielded antioxidant peptides, including YFYPEL from bovine casein and casein with pepsin, trypsin, and chymotrypsin. Milk peptides with amino acid sequences ARHPHPHLSFM, AVPYPQR, NPYVPR, and KVLPVPEK reduced lipid peroxidation in Caco-2 cells by activating the Keap1-Nrf2 system (Bouzid, et al., 2023). Cheddar, Gouda, cottage cheese, Pategrás, and Crescenza cheese contain bioactive peptides that bind metal ions and inhibit lipid oxidation (Mokaya, et al., 2023). Water-soluble yogurt extracts include antioxidant peptides. These antioxidative peptides protect against free radicals and active oxygen species. High levels of bioactive peptides from αs- and β-casein in buffalo milk cheddar cheese stimulated glutathione production (Fan, et al., 2023).

2.4 Meat and meat products: Organ meats, such as liver, contain a high concentration of antioxidants, which include zinc, selenium, and the vitamins A, E, and C. These antioxidants assist to scavenge damaging free radicals. Among the chemicals that are helpful to the eyes that can be found in egg yolks are lutein and zeaxanthin. As a result of the significant amount of protein that they contain, meat and products made from meat contain bioactive peptides (Eissa et al., 2023). During the postmortem aging of meat, it is possible to develop bioactive peptides with a molecular weight of less than 3 kDa. However, the type and amount of these peptides are dependent on temperature, pH, and enzymes like as pepsin, chymotrypsin, elastase, and trypsin (Li, et al., 2023). In beef, hog, mutton, chicken, deer, duck, and marine animals, the majority of antioxidant peptides that are formed from myofibrilla and sarcoplasmic proteins and range in length from two to twenty amino acids are identified (Choi, et al., 2023). These peptides are found in a variety of

different species. The hydrolysis of pig proteins with papain resulted in the production of peptides with molecular weights ranging from three to ten kilodaltons that contained the amino acid sequences DAQEKLE, AKHPSDFGADAQ, and AKHPSDFGADAQA (Shastak et al., 2023). These peptides possessed powerful antioxidant properties. Peptides that were generated from myofibrillar proteins and contained the amino acid sequences KRQKYD, EKERERQ, KAPVA, PTPVT, RPR, GLSDGEWQ, GFHI, DFHING, and FHG demonstrated powerful antioxidant properties (Rind et al., 2023). These peptides were found to have a high level of antioxidant activity. Papain and actinase E are responsible for the hydrolysis of porcine myofibrilla proteins, which results in the production of the peptides DSGVT, IEAEGE, EELDNALN, VPSIDDQEELM, and DAQEKLE (Estivi et al., 2023). According to Kwaśniewska et al. (2023), fermented and cured meat products contained a number of peptides that possessed antioxidant properties. These peptides included DSGVT, IEAEGE, EELDNALN, VPSIDDQEELM, DAQEKLE, ATA, SLTA, VT, SAGNPN, GLAGA, DLEE, FGG, and DM. There are a number of antioxidants that can be found in meat, poultry, and fish (Mardani et al., 2023). These antioxidants include carnosine, anserine, glutathione, and ophidine. Free radicals are neutralized by carnosine, anserine, and ophidine, all of which have structures that are comparable to one another. Assar et al. (2023) state that they are able to prevent the oxidation of lipids that is brought on by free radicals, ionic iron, hemoglobin that has been activated by hydrogen peroxide, singlet oxygen, and other processes. The research conducted by Janmohammadi et al. (2023) indicates that antioxidants, such as glutathione, have the ability to neutralize reactive oxygen species and prevent oxidant-mediated cell death. According to Pruteanu et al. (2023) and Czelej et al. (2023), the amount of these compounds that are found in meat is influenced by a number of factors, including breed, age, gender, and breeding program.

According to El-Sabrout et al. (2023), antioxidant properties were exhibited by traditional Chinese chicken peptides that contained the amino acid sequences HVTEE and PVPVEGV. Alpha, SLTA, and VT are three oligopeptides that include two to four amino acids. These oligopeptides demonstrated antioxidant qualities and activity in tests that were conducted in vitro as well as in vivo (Klein et al., 2023). According to Shiry et al. (2023), these antioxidant peptides have the potential to serve as a substitute for manufactured dietary antioxidants, even though this hypothetical scenario is not practicable. Antioxidant peptides can be produced from a variety of sources, including meat, products derived from meat, and byproducts of the processing of meat. A study by Hashem et al. (2023).

2.5 Skin collagen

It is normal practice to manufacture bioactive peptides as leftovers from the collagen found in the skin. According to Yu et al. (2023), the process of hydrolyzing collagen from pig skin results in the production of a mixture of antioxidant peptides that contain the amino acid sequences QGAR, LQGM, LQGMH, and HC sequences. The experiment that was carried out by Yohana and colleagues in 2023 resulted in the production of three antioxidant peptides by making use of proteins derived from water buffalo horn. These peptides have the sequences QYDQGV, YEDCTDCHN, and AADNANELFPPN at the beginning of their amino acid base. Elastase was used to break down the skin of broiler hens, which resulted in the production of peptides of the amino acid sequences GAHTHPRLPFKPR, GMPGFDVR, and ADASVLPK. According to Liu et al.'s 2023 research, the peptides shown high antioxidant activity against several radicals, including DPPH and ABTS. In the process of hydrolyzing pancreatic collagen from pigs, papain and protease were applied, which resulted in the formation of peptides that have powerful antioxidant capabilities. According to Tawalbeh et al.'s 2023 research, the substantial bulk of the peptides that were produced were dipeptides.

2.6 Blood proteins

There was also a strong demonstration of antioxidant activity in blood plasma hydrolysates (with AlcalaseR 2.4 L); the peptides that were responsible for the antioxidant action were GAHQPSG and QQPVRDOQ. (Czlapka-Matyasik, M., & Gramza-Michalowsk) The enzymes alcalase, pepsin, trypsin, papain, and flavorzyme are the ones that are utilized the most frequently in the process of collecting antioxidative peptides from blood obtained from slaughterhouses. (Gadd et al., 2023)

2. Mechanism of action of Antioxidants

The mechanism of action of animal-based antioxidants involves their ability to neutralize harmful reactive oxygen species (ROS) and free radicals in biological systems. These antioxidants, such as vitamins A, C, and E, carotenoids, and selenium found in animal-derived foods, exert their protective effects through various pathways. Primarily, they donate electrons or hydrogen atoms to unstable ROS, thereby stabilizing them and preventing oxidative damage to cellular components like DNA, proteins, and lipids. Additionally, some animal-based antioxidants may chelate transition metal ions, such as iron and copper, which catalyze the formation of highly reactive radicals. Moreover, certain antioxidants modulate gene expression and activate endogenous antioxidant defense systems, enhancing the body's ability to counteract oxidative stress. Overall, the cation of animal-based antioxidants involves a multifaceted interplay of direct scavenging, metal ion chelation, and regulatory mechanisms, collectively contributing to their beneficial effects on health and disease prevention (Tan, et al., 2023; Garza-Juárez et al., 2023)

Figure 1: Mechanism of Action of Animal based Antioxidants

3. Characteristic Applications of Animal derived Antioxidants

According to Czlapka-Matyasik et al. (2023), antioxidants originating from animals are created from proteins either by hydrolyzing them with enzymes or during digestion. These antioxidants become active only once the proteins' functional peptides are liberated. The anti-inflammatory, hypoglycemic, antithrombotic, and ACE inhibitory properties of some peptides and single amino acids are crucial for maintaining human health (Torres-Castillo et al., 2023). After removing proteins from animal tissues, enzymatic hydrolysis creates antioxidants derived from animals. Enzymes such as pepsin, trypsin, elastase, chymotrypsin, proteases, and alcalase are frequently employed in the synthesis of bioactive peptides possessing antioxidant properties. These bioactive peptides have a molecular weight of less than 6 kDa and range in amino acid content from 3 to 20 (Jia, et al., 2023). The temperature, pH, salt concentration, and hydrolysis enzymes all affect how stable the antioxidants derived from animals are. These peptides have a very high level of activity and bloodstream absorption because of their modest molecular weight and stable structure (Untea et al., 2023). According to Melado-Negrete et al. (2023), these antioxidant peptides work on lipid oxidation promoters like Fe2+, Cu2+, H2O2, lipid peroxides, NO, and other aldehydes to stop or slow down lipid oxidation in food systems. This will stop damage to essential cell components like DNA, proteins, lipids, and hormones. It is unclear, therefore, whether antioxidant peptides can stop an oxidative process (Chen, et al., 2023).

Because natural antioxidants are thought to be safe and have fewer negative health effects than synthetic antioxidants utilized in the food, pharmaceutical, or nutraceutical industries, natural antioxidants produced from animal sources are advised as a substitute for the latter (Papaefthimiou, et al., 2023). Below is a discussion of a few particular antioxidants from an animal-based diet.

4.1 Bioactive: Peptides are medicinal compounds that are utilized to enhance human health. Peptides include antibacterial, anti-inflammatory, anticancer, and immunomodulatory properties in addition to their antioxidant activities. They can also prevent type II diabetes (Wang et al., 2023). Antioxidant peptides have been proposed by numerous researchers as a natural antioxidant in food products that also enhance their sensory qualities. (Mohammed et al., 2023).

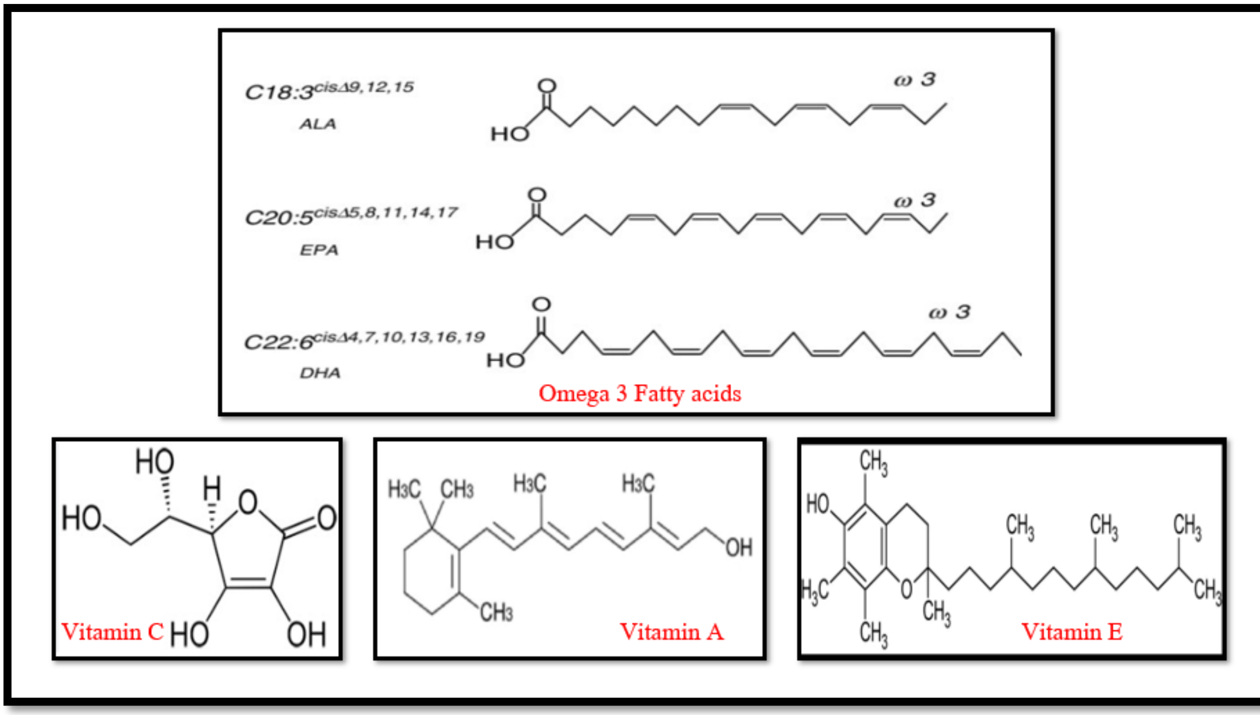

Figure 2: Structure of some selected Animal based Antioxidants Sylvester, and Shah, 2005; Chiu et al., 2019; Al-Fartusie, 2021)

4.2
Omega 3 fatty acids: Found abundantly in fatty fish like salmon, mackerel, and trout, omega-3 fatty acids are renowned for their anti-inflammatory properties and their ability to combat oxidative stress. EPA and DHA, two types of omega-3s, not only serve as antioxidants themselves but also enhance the effectiveness of other antioxidants within the body. These fatty acids are crucial for cardiovascular health, brain function, and reducing the risk of chronic diseases like heart disease and arthritis (Wang, et al., 2023).

4.3 Vitamin A, E, and C: Organ meats, particularly the liver, are rich sources of vitamins A and E. Vitamin A, in the form of retinol, plays a vital role in maintaining healthy vision, immune function, and skin integrity. Vitamin E acts as a powerful antioxidant, protecting cells from damage caused by free radicals and supporting immune function. Vitamin C, while more commonly associated with fruits and vegetables, can also be found in small amounts in animal products like liver and eggs. It is essential for collagen synthesis, immune function, and aiding in the absorption of iron (Kaura et al., 2022)

4.4 Selenium: Organ meats and dairy products are notable sources of selenium, an essential mineral that functions as a cofactor for antioxidant enzymes like glutathione peroxidase. Selenium helps neutralize harmful free radicals, supports thyroid function, and plays a crucial role in DNA synthesis and immune response (Zhang and Bai, 2023).

4.5 Zinc: Like selenium, zinc is found in organ meats and dairy products and serves as a cofactor for various antioxidant enzymes. It plays a critical role in immune function, wound healing, and DNA synthesis. Zinc also contributes to the maintenance of healthy skin, vision, and cognitive function. (Sethi et al., 2019, Wang et al., 2023)

Table 2: Applications of Animal-based Antioxidants

Antioxidants	**Applications**	**Reference**
Omega-3 Fatty Acids	• Cardiovascular health: Reduce triglyceride levels, lower blood pressure, prevent plaque buildup in arteries. • Brain health: Support cognitive function, reduce the risk of cognitive decline. • Eye health: Prevent age-related macular degeneration.	Khan et al., 2023

Antioxidants	Applications	Reference
Vitamin A	• Vision health: Maintain healthy vision, especially in low light conditions. • Immune function: Support immune system function, particularly in mucous membranes. • Skin health: Promote healthy skin and wound healing.	Pludowski et al., 2023
Vitamin E	• Skin health: Protect skin from UV damage, reduce signs of aging. • Immune function: Enhance immune response and protect against infections. Cardiovascular health: Prevent oxidative damage to LDL cholesterol.	Xiong et al., 2023
Vitamin C	• Immune support: Boost immune function and protect against infections. Collagen synthesis: Aid in wound healing and maintain healthy skin, bones, and blood vessels. • Antioxidant activity: Neutralize free radicals and protect cells from damage.	Lankadeva et al., 2023
Selenium	• Antioxidant defense: Protect cells from oxidative damage caused by free radicals • Thyroid function: Support thyroid hormone production and metabolism. • Cancer prevention: Reduce the risk of certain cancers by preventing DNA damage.	Zhang and Bai, 2023
Zinc	• Immune function: Enhance immune response and protect against infections Wound healing: Promote tissue repair and regeneration. S • Skin health: Support healthy skin, hair, and nails.	Wang et al., 2023

The expense of producing animal-derived antioxidants to separate particular antioxidant peptides is too high for practical application, despite the fact that some of them are known to have antioxidant capacities that are comparable to those of synthetic antioxidants (Zhang et al., 2023). Numerous peptides, including the particular antioxidant peptide, can provide numerous other biological features that can improve human health if the entire enzyme hydrolysate is utilized to create animal-based antioxidants employed in food (Stabili, et al., 2023). Thus, complete protein hydrolysate is a superior ingredient to employ in a food product than isolating and using a particular antioxidant peptide (Olas, et al., 2023). This idea is crucial because customers are becoming increasingly concerned about their health, and food products that contain natural antioxidants and functional peptides will meet market demands. (Hassanpour, et al., 2023).

4. Conclusion

The future outlook for animal-based antioxidants is promising, with ongoing research poised to unveil new compounds and applications in various fields. Novel antioxidants may emerge from exploration into diverse animal sources, potentially uncovering potent free-radical scavengers in lesser-known species or specific animal tissues. Understanding the bioavailability of these compounds will be crucial, driving efforts to enhance absorption and utilization through innovative delivery systems. These antioxidants hold the potential for incorporation into functional foods, dietary supplements, and health products, catering to consumer interest in natural and holistic approaches to wellness. Moreover, their inclusion in nutritional fortification could address micronutrient deficiencies and contribute to overall health, especially in underserved populations. Therapeutic applications for managing oxidative stress-related conditions, such as chronic diseases and neurodegenerative disorders, may also be explored. Sustainable sourcing practices and ethical considerations will play a pivotal role, in shaping the development of responsibly derived animal antioxidants. Ultimately, personalized nutrition approaches could leverage these compounds to optimize individual health outcomes, highlighting the multifaceted potential of animal-based antioxidants in promoting well-being and disease prevention.

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