The Biotechnological Impact of Royal Jelly, Apilarnil, and Propolis on Sturgeon – a Review

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Abstract
Bee products such as royal jelly, apilarnil, and propolis are well known for their bioactive properties and have shown significant applications across various fields, including aquaculture. This review provides a systematic analysis of the potential role of these substances in sturgeon biotechnology, focusing on their effects on growth, development, immune modulation, and stress resistance. The study synthesizes existing literature and highlights future perspectives regarding the use of apicultural products to enhance the biological performance and welfare of sturgeons in aquaculture systems.

Keywords: bee products, aquaculture, biotechnology, biological performance

1. Introduction

Sturgeon aquaculture has gained major importance due to the sharp decline of wild populations and the increasing demand for sturgeon products (meat, caviar, etc.). These trends make sustainable technologies and innovative biotechnological solutions necessary for their growth and development. In aquaculture, natural products are increasingly studied as supplements for enhancing health and immunity [1,2]. Bee products – particularly royal jelly, apilarnil, and propolis – contain bioactive compounds (proteins, vitamins, hormones, flavonoids, fatty acids) with well-known antioxidant and immunomodulatory effects [3]. Propolis is considered “one of the best natural antibiotics” due to its content of flavonoids and phenolic compounds [2]. Therefore, the administration of these supplements could support sturgeon immunity, metabolism, or reproduction; however, scientific evidence remains limited at this time. The present review synthesizes the available data regarding their potential role in sturgeon aquaculture.

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2. Materials and methods

International peer-reviewed scientific papers investigating the use of royal jelly, apilarnil, or propolis in sturgeons were selected. The bibliographic search was conducted in specialized databases (SCOPUS, Web of Science, Google Scholar) using terms such as “Acipenser royal jelly,” “sturgeon apilarnil,” “sturgeon propolis,” “Acipenser bee products.” Only original studies on sturgeons and specifically addressing these bee products were included. The results were critically analysed to highlight the reported effects on sturgeon growth, physiology, and health. Studies involving other fish species were excluded in order to avoid drawing unjustified conclusions.

Royal jelly

The literature dedicated to the use of royal jelly in sturgeons is extremely limited. Royal jelly is a complex nutritional supplement composed mainly of water (60–70%), proteins (9–18%), and glucose/fructose (7–18%) [3]. It also contains B-

complex vitamins, fatty acids (particularly 10-HDA), hormones, and polyphenols. In general, RJ exerts antioxidant effects and modulates immune responses [3–7]. However, no published studies directly evaluate the impact of royal jelly on sturgeons. The bioactive properties of RJ (ability to reduce oxidative stress, enhance immunity) suggest potential benefits for growth and stress resistance in sturgeons, but these hypotheses have not been tested in these species. Therefore, in the absence of species-specific data, no firm conclusions can be drawn regarding the effects of royal jelly on sturgeon development, metabolism, or reproduction—an area that requires dedicated research.

Apilarnil

Apilarnil is obtained from drone honeybee larvae and is considered a strong endocrine stimulant. Its chemical composition includes proteins, fatty acids, vitamins, and steroid hormones [4]. Analytical studies have shown that drone larvae contain oestradiol, progesterone, and testosterone [4,8,9]. For this reason, apilarnil exhibits antioxidant, immunotropic, adaptogenic, and anabolic activities [4,10,11] and is claimed to stimulate sexual development and body anabolism. In research on other vertebrates, the administration of apilarnil increased muscle growth and the development of male sexual characteristics due to its androgenic effect. In sturgeons, the regulation of steroid hormones is essential for male reproduction, with testosterone being the key hormone in gonadal maturation in Persian sturgeon [12–14]. By analogy, the administration of apilarnil could potentially improve male reproductive parameters in sturgeons (such as sperm quantity, motility, and hormonal levels); however, no experimental studies have yet been published to confirm these effects in sturgeon species. Thus, although its properties suggest a potential role in improving male fertility, the actual applicability of apilarnil in sturgeon reproduction remains unclear and requires targeted investigations.

Propolis

Propolis is a resinous mixture produced by bees, rich in flavonoids, phenolic acids, and compounds with diverse biological effects. Due to its antibacterial, antiviral, and antifungal properties, propolis is considered an excellent natural antibiotic [2]. In aquaculture, propolis has been studied as an immunostimulant. In the study by Eslami et al. (2022), it was demonstrated that a 60-day dietary supplementation with 2–3% ethanolic extract of propolis in juvenile beluga sturgeon (*Huso huso*) did not result in significant weight gain but enhanced digestive enzyme activities and potentiated hepatic antioxidant mechanisms. Moreover, sturgeons receiving 2–3% propolis extract showed increased leukocyte counts, higher lysozyme activity in skin mucus, and elevated immunoglobulin levels in mucus. An in vitro antibacterial effect of serum against *Aeromonas hydrophila* was also stronger in fish fed with 2–3% propolis compared to the control group [1]. These findings indicated that supplementation with propolis extract, particularly at 3%, may exert beneficial effects by enhancing digestive enzyme activity, increasing hepatic antioxidant capacity, and improving immune responses in beluga sturgeons. Conversely, studies on sterlet larvae (*Acipenser ruthenus*) reported adverse effects of propolis. Thus, Mocanu et al. (2022) tested three groups maintained in RAS: control, vitamin-supplemented, and propolis-supplemented. Their results showed that propolis addition reduced body growth and increased larval mortality, with mortality rates significantly higher in the propolis-fed group compared to controls. While vitamin-enriched diets improved growth and survival parameters, propolis was associated with increased mortality [2]. This discrepancy suggests that the efficacy of propolis depends on the dosage, the form of administration, and the developmental stage of the fish. Overall, recent studies indicate that propolis can act as an immunostimulant and antioxidant in sturgeons (enhancing non-specific defense), but these effects must be carefully managed—uncontrolled administration may lead to negative consequences (e.g., increased mortality in larvae) [15,16].

3. Discussion

The available results provide mixed perspectives on the use of bee products in sturgeon culture. The bioactive compounds of royal jelly, apilarnil, and propolis—including valuable proteins, hormones, polyphenols, and vitamins—are associated with potential immunostimulatory and antioxidant effects. For instance, the administration of propolis to beluga sturgeon improved digestive

and immune parameters without negatively affecting body growth [1]. In the case of apilarnil, the presence of androgenic hormones suggests a possible influence on male sexual maturation, similar to other vertebrates [4]. However, the scientific literature presents significant limitations: studies on royal jelly in sturgeons are virtually absent, and for propolis there is no consensus regarding optimal dosages and administration methods, with results sometimes divergent (e.g., Eslami vs. Mocanu). Moreover, the compositional variability of bee products, determined by their source and processing, complicates the reproducibility of findings. Methodologically, evaluating their effects in sturgeons requires well-defined protocols, sufficiently large experimental groups, adequate controls, and extended administration periods. Concentrations applied to other species cannot be directly extrapolated to sturgeons due to their distinct metabolic characteristics [17,18]. The scarcity of comprehensive published research reflects logistical and ethical challenges in conducting such experiments. Overall, the available data support the notion that bee products hold real potential for improving sturgeon health (via antioxidant and immunostimulant effects), but their practical application requires validation through additional studies.

4. Conclusions

Synthesizing the current literature, bee products may represent promising additives in sturgeon biotechnology due to their antioxidant and immunostimulatory properties [1,19]. However, specific studies on sturgeons are needed to confirm the presumed beneficial effects of royal jelly and apilarnil. The available studies highlight the necessity of rigorous standardization: both in production procedures (purity, dosage) and in experimental protocols (dose per fish, treatment duration, evaluation metrics). Future research directions include the systematic testing of RJ and apilarnil supplements on sturgeon growth, immunity, and reproduction, as well as the optimization of propolis concentrations to maximize benefits without adverse effects. In conclusion, bee products may provide advantages in sturgeon aquaculture, but their effective utilization requires further scientific investigation and the establishment of standardized protocols.

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