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# The Use of Prebiotics in the Diet of Cyprinids: From Production Performance to Host Health

Horia-Ioanid STAN<sup>1</sup>, Cristian-Alin BARBACARIU<sup>2</sup>, Cristina-Gabriela RADU-RUSU<sup>1</sup>, Daniel SIMEANU<sup>1</sup>  
<sup>1</sup>"Ion Ionescu de la Brad" University of Life Sciences

<sup>2</sup>Research and Development Station for Aquaculture and Aquatic Ecology, "Alexandru Ioan Cuza" University

**Abstract:** Cyprinids, especially common carp (*Cyprinus carpio*), are important freshwater species in Romanian aquaculture. This paper reviews the use of prebiotics such as MOS, FOS, GOS, inulin,  $\beta$ -glucans and other compounds in cyprinid nutrition. Available studies indicate positive effects on growth, feed conversion, gut morphology, microbiota balance, immune response, antioxidant status and pathogen resistance. However, these effects depend on prebiotic type, dose, administration period, fish species, age and rearing conditions. Overall, prebiotics are promising tools in cyprinid nutrition, but their practical use requires context-specific optimization.

## • Introduction

Aquaculture has an increasing role in aquatic food production, while carps and other cyprinids remain among the main groups of farmed freshwater fish. In Romania, cyprinid species such as common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Hypophthalmichthys nobilis*) and Prussian carp (*Carassius gibelio*) are central to freshwater aquaculture. However, bacterial diseases and excessive antibiotic use require safer nutritional strategies. Therefore, prebiotics are increasingly studied as functional feed additives able to support gut microbiota, immunity, growth and fish health.

## • Material and method

A structured literature review was performed using Web of Science, Scopus, PubMed and Google Scholar, covering studies published between 1995 and 2026. The analysis focused on prebiotics used in cyprinid nutrition. When studies included combined treatments, such as synbiotics or other functional additives, only data from separate groups receiving prebiotics alone were extracted and discussed.

## • Results and discussions

### ➤ Historical background and definition

Prebiotics were first defined by Gibson and Roberfroid in 1995 as non-digestible food ingredients that selectively stimulate beneficial intestinal bacteria. In 2017, the ISAPP consensus statement broadened the concept, defining a prebiotic as "a substrate that is selectively utilized by host microorganisms conferring a health benefit". In aquaculture, one of the first reported dietary applications was the use of lactosucrose in red seabream (*Pagrus major*) in 1995.

### ➤ The main types of prebiotics used in aquaculture

In aquaculture, prebiotics mainly include non-digestible or poorly digestible oligosaccharides, fructans and polysaccharides. In cyprinids, the most studied compounds are MOS, FOS, GOS, XOS, inulin,  $\beta$ -glucans and chitosan derivatives. More recent studies also include pectin, alginate oligosaccharides, fucoidan and laminarin as emerging prebiotic compounds. Among these compounds, MOS, FOS, GOS, XOS, inulin,  $\beta$ -glucans, chitosan derivatives, pectin, AOS and fucoidan have been reported in studies involving cyprinid species.

### ➤ Mechanisms of action

Prebiotics act mainly in the gastrointestinal tract by stimulating beneficial bacteria, especially lactic acid bacteria, and reducing opportunistic or pathogenic bacteria. Through fermentation, they contribute to the production of short-chain fatty acids, such as acetate, propionate and butyrate. They may also improve digestive enzyme activity, intestinal morphology and non-specific immune responses, including lysozyme, complement activity and immune-related gene expression.

### ➤ Effects of prebiotics in cyprinids

The available evidence indicates that prebiotics act as multifunctional dietary additives in cyprinids. Their most consistent effects are related to improved growth and feed utilization, enhanced digestive and intestinal function, modulation of gut microbiota, stimulation of innate immunity, strengthening of antioxidant defense and increased resistance to pathogens and environmental stressors. However, the magnitude of these responses depends on prebiotic type, dose, administration period and rearing conditions.

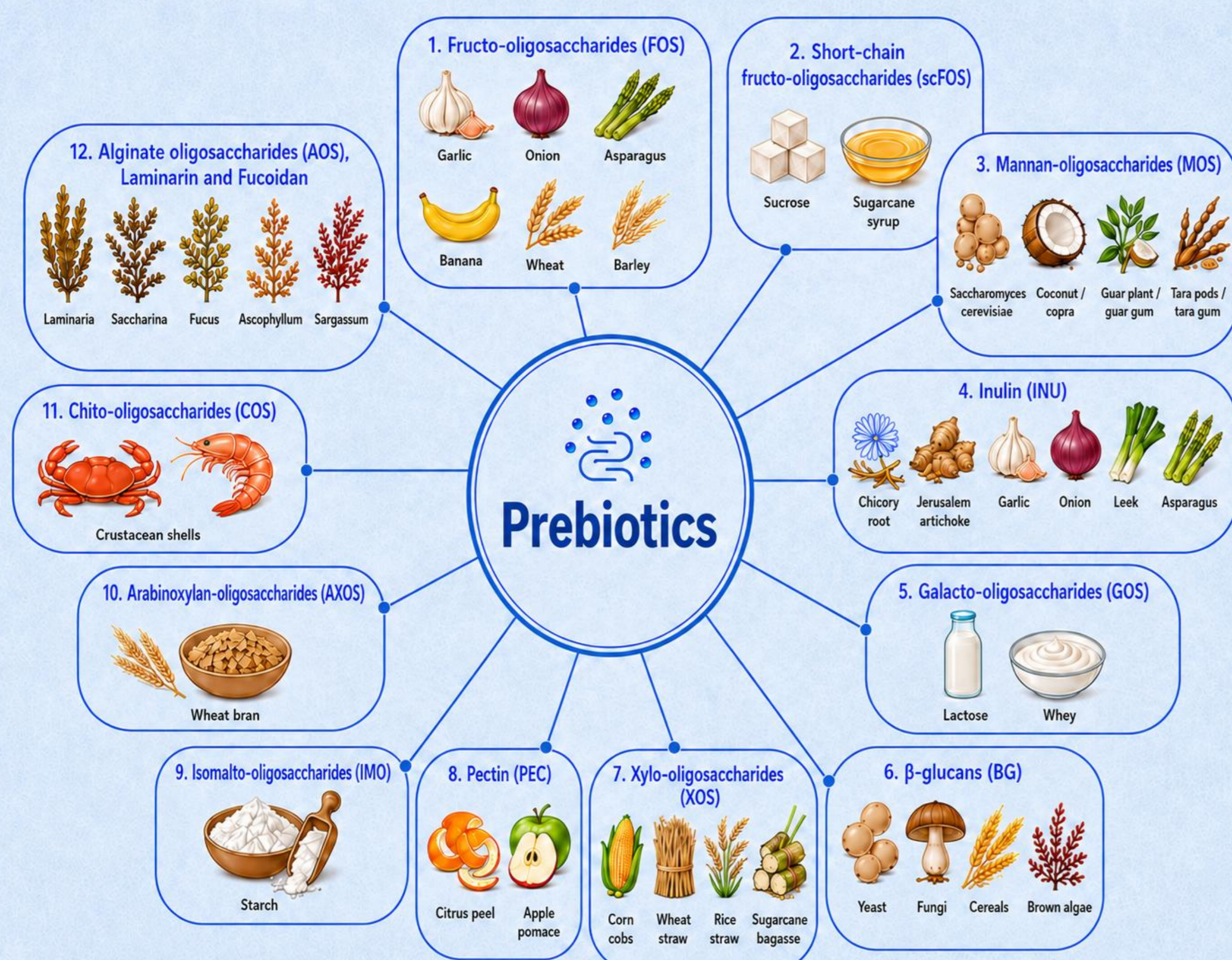


Figure 1. Main types and sources of prebiotics used in aquaculture (AI-generated image)

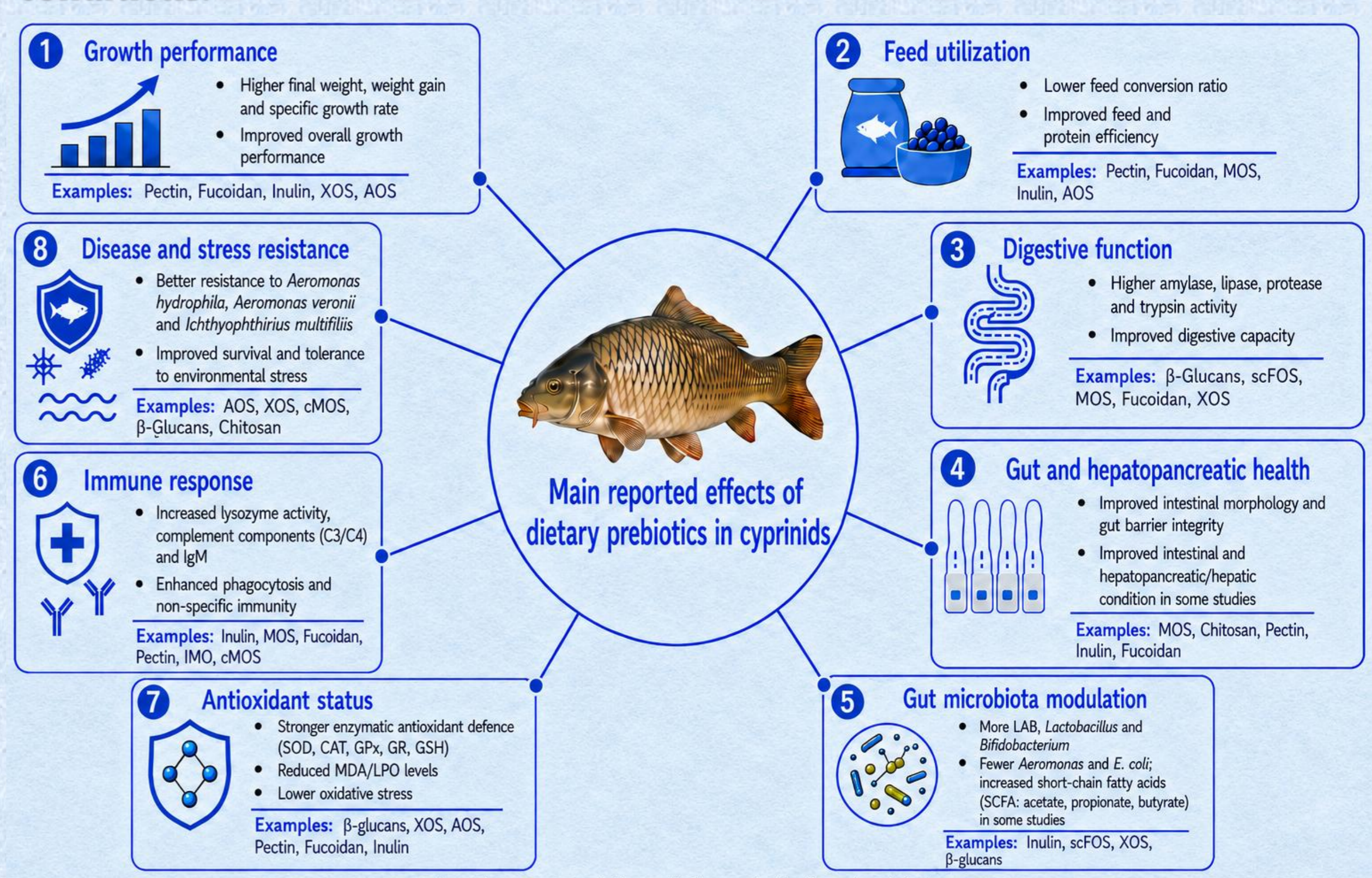


Figure 2. Main reported effects of dietary prebiotics in cyprinids (AI-generated image)

## • Conclusions

Dietary prebiotics represent a promising nutritional strategy for cyprinid aquaculture, supporting both productive performance and fish health. The reviewed studies indicate positive effects on growth, feed conversion, gut microbiota balance, non-specific immune response, antioxidant status and resistance to pathogens. However, these effects are not uniform and depend on fish species, developmental stage, prebiotic type, dietary dose, feeding period and rearing conditions. Further studies are needed to establish optimal inclusion levels and clarify the mechanisms through which prebiotics contribute to fish health.