nagi bioscience

CASE STUDY

Evaluating the impact of a yeast-derived functional ingredient on longevity.

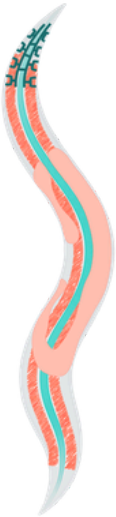
Early *in vivo* insights into UpFiber® Beta-Glucan targeting healthy aging.

Nutritional supplements and functional foods are expanding rapidly, driven by increasing consumer demand for products that support gut health, immune resilience, metabolic balance, and healthy aging. As more products enter the market, differentiation can no longer rely only on ingredient origin, nutritional composition, or formulation advantages. **Nutraceutical developers need functional data to prioritize ingredients that produce measurable biological impact in relevant living systems.**

The key question is, therefore, how to generate early, whole-organism data that can inform the selection, prioritization, and further development of functional ingredients.

C. elegans: a favorable model in pioneering nutrition science

As a leading model in aging research, *C. elegans* has been extensively used to study lifespan and healthspan, both of which can be regulated by dietary manipulation (1). This relevance can be explained by the conserved nutrient-sensing metabolic pathways, including insulin/IGF signaling and lipid metabolism (2). Additionally, as a bacterivorous organism, its physiology is directly influenced by bacterial composition and metabolism, enabling controlled investigation of host-microbiome interactions. By combining conserved metabolic and aging pathways **with intrinsic host-microbe interactions, *C. elegans* provides a promising screening tool for functional foods and ingredients on metabolic health, stress-associated phenotypes, and longevity.**



A nutritional model

C. elegans shares highly conserved nutrient-sensing pathways with mammals, including insulin/IGF-1 signaling, AMPK, mTOR, and FOXO-mediated stress responses, which regulate energy balance, metabolism, and aging.

Tractable host–microbiome interactions

C. elegans feeds on bacteria, allowing precise control of the microbial environment and straightforward manipulation of host–microbe interactions.

Applications

- Screen interventions for functional ingredients.
- Capture microbiome-dependent effects.

All bioactivities of dietary nutrients studied using *C. elegans*

Carbohydrates:
Glucose, Fructose, Sucrose, Oligosaccharides, Polysaccharides
(3)

Lipids & fatty acids:
Linoleic and linolenic acids, Oleic, arachidonic, eicosapentaenoic, and docosahexaenoic acids (3)

Proteins, Vitamins & Minerals
B12, C, D, E, Folate, Zinc, Iron, Calcium, Selenium
(3)

Experimental workflow of Nagi Bioscience and representative readouts

Lifespan and healthspan-relevant phenotypes are quantified using Nagi™ C-Age, while biological age is assessed using Nagi™ B-Age, a phenotypic clock integrating more than 20 biomarkers. This approach enables decomposition of biological age into trait-specific contributions, including intestinal features such as morphology and atrophy, providing a multidimensional evaluation of ingredient effects on organismal health. The schematic below illustrates the workflow and shows representative examples of the analytical results that can be obtained by the technology.

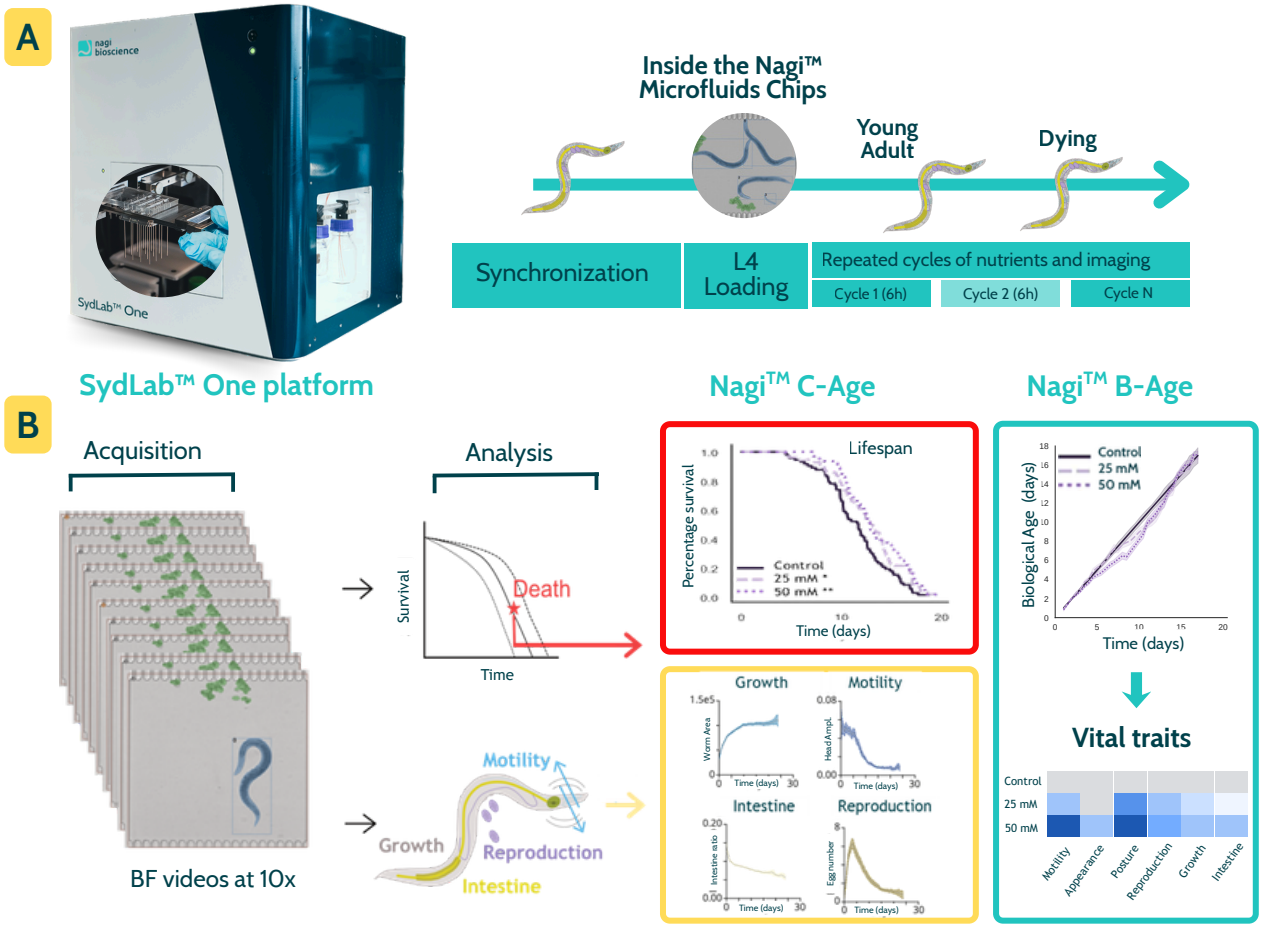


Figure 1. Schematic representation of Nagi Bioscience's automated workflow. Worms are loaded at the L4 larval stage into Nagi™ microfluidic chips and maintained under controlled feeding (freeze-dried OP50) and environmental conditions throughout the experiment (A). Repeated brightfield videos enable continuous monitoring of survival, motility, growth, reproduction, posture, and intestinal morphology using Nagi™ C-Age, while biological age and trait-specific healthspan parameters are quantified using Nagi™ B-Age (B). Graphs are illustrative examples and do not represent the experimental results of this case study.

How Nagi Bioscience delivered insights into the functional impact of UpFiber® Beta-Glucan

Yeastup AG is a food tech company developing functional ingredients from brewer's spent yeast. Through an upcycling approach, the company transforms brewery by-products into high-value yeast-derived proteins and fibers for functional ingredients. With the SydLab™ One platform and Nagi™ B-Age, Yeastup AG evaluated the functional impact of a yeast-derived beta-glucan ingredient, UpFiber® Beta-Glucan, across five concentrations in *C. elegans.*

Results

UpFiber® Beta-Glucan was dissolved in the appropriate solvent (water) and administered to *C. elegans* together with the food (freeze-dried OP50) across five concentrations. The solvent-only condition served as the negative control, while a 20% caloric-restrictive (CR) diet was included as a positive control, as it's well studied for its benefits in aging and longevity (4). The results below reveal **that UpFiber® Beta-Glucan induced broad, dose-dependent effects on *C. elegans* healthspan, such as enhanced motility and improved biological-age parameters, including intestinal health.**

Enhanced Motility

Motility in *C. elegans* is a critical endpoint of healthspan assessment, as it requires functional neuromuscular signaling, body-wall muscle integrity, sufficient energy production, and coordinated responses (5). In aging studies, improved motility is interpreted as a sign of preserved neuromuscular health and extended healthspan. *C. elegans* body-wall muscle is structurally and functionally comparable to vertebrate skeletal muscle, with conserved molecular components contributing to sarcomere organization and muscle function (6). In humans and mice, reduced muscle performance, commonly assessed by measures like grip strength, is strongly associated with frailty, morbidity, and mortality (7). **Thus, motility outcomes in *C. elegans* can provide a useful conceptual bridge between experimental interventions in simple models and functional outcomes relevant to healthy aging in humans.**

In this study, four motility parameters were monitored: head movement amplitude, tail movement amplitude, bending frequency, and velocity, all of which showed comparable outcomes. Here, we present the results for head movement amplitude, a measure associated with the preservation of muscle function, and bending frequency, an indicator of neural integrity and locomotor vigor in *C. elegans*.

Head Amplitude

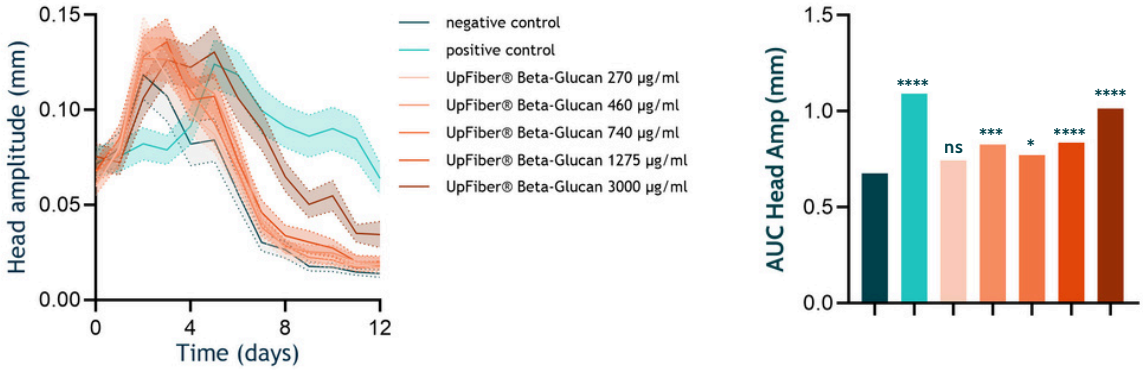


Figure 2. Head amplitude movement was measured longitudinally. Statistical analysis was performed using two-way ANOVA to assess overall differences across curves, followed by Bonferroni's multiple comparisons test.
* p<0.05, *** p<0.001; **** p<0.0001

Bending frequency

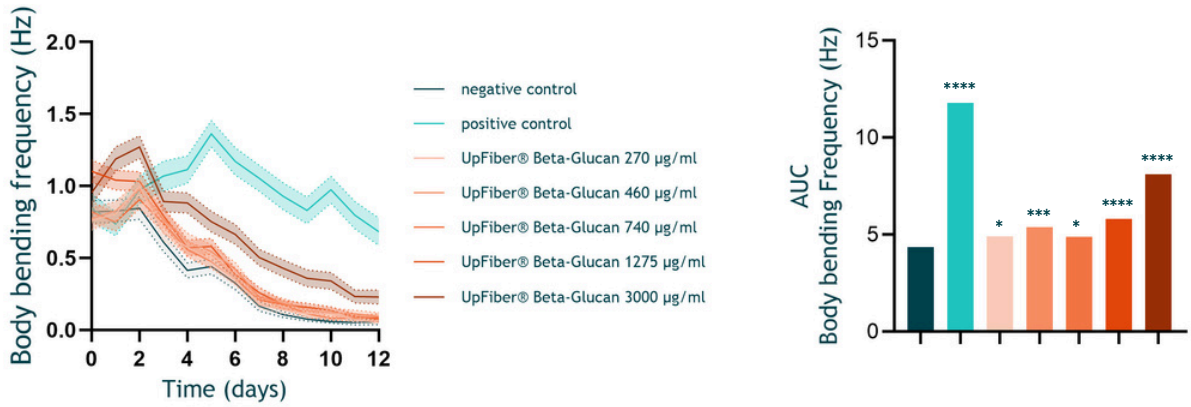


Figure 3. Locomotion was measured longitudinally. Statistical analysis was performed using two-way ANOVA to assess overall differences across curves, followed by Bonferroni's multiple comparisons test.
* p<0.05, *** p<0.001; **** p<0.0001

Reproduction

UpFiber® Beta-Glucan extended the reproductive period and advanced sexual maturity (egg emergence) while reducing total egg output (fertility). Although reduced fecundity is also observed at the CR diet (positive control), UpFiber®/yeast-derived beta-glucan appears to have a distinct profile, supporting effects beyond simple nutrient restriction, highlighting the value of multidimensional phenotyping for functional ingredient evaluation.

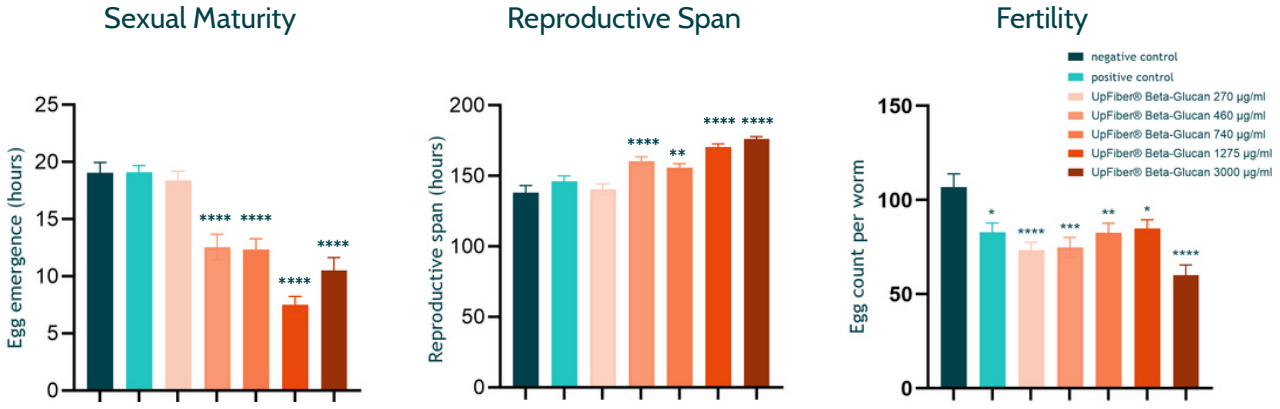


Figure 4. Graphical representation of *C. elegans* reproductive dynamics across five different concentrations under UpFiber® Beta-Glucan administration. The timing of sexual maturity, reproductive span, and the average number of eggs (fertility) were analyzed across groups. Statistical analysis was conducted using one-way ANOVA comparing the negative control to all other conditions, followed by Bonferroni's multiple comparisons test.
* p<0.05, ** p<0.01; *** p<0.001, **** p<0.0001

The Nagi health span approach allowed us to explore the potential benefits of beta-glucan consumption on biological ageing and physiology. It was especially interesting to test various concentrations of our product, which resulted in a clear dose-dependent effect. The work forms our basis to explore the health benefits of beta-glucan further.

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CTO at Yeastup

Improved Biological Age

To further investigate the impact of UpFiber® Beta-Glucan, Nagi™ B-Age was used to quantify the biological age of *C. elegans* and identify trait-specific improvements. The biological age prediction was further decomposed into individual vital traits using a multiparametric approach that evaluates over 20 phenotypic biomarkers. These traits represent how the organism allocates energy at different time points.

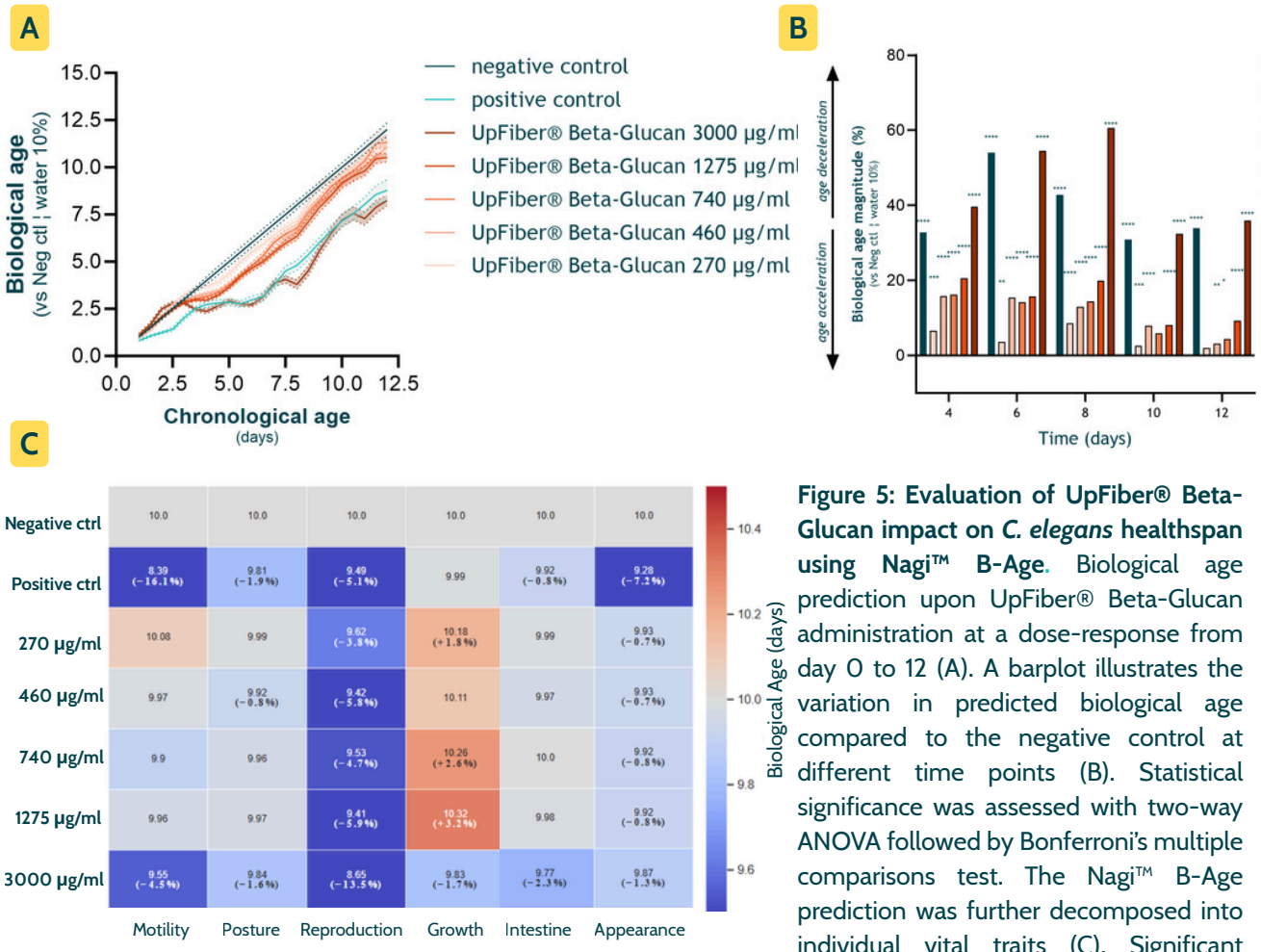

Figure 5: Evaluation of UpFiber® Beta-Glucan impact on *C. elegans* healthspan using Nagi™ B-Age. Biological age prediction upon UpFiber® Beta-Glucan administration at a dose-response from day 0 to 12 (A). A barplot illustrates the variation in predicted biological age compared to the negative control at different time points (B). Statistical significance was assessed with two-way ANOVA followed by Bonferroni's multiple comparisons test. The Nagi™ B-Age prediction was further decomposed into individual vital traits (C). Significant changes in biological age, relative to the control, are expressed as percentage improvements or deteriorations. The overall change in biological age reflects the cumulative effect of changes across all vital traits. * p<0.05, ** p<0.01; *** p<0.001, **** p<0.0001

UpFiber® Beta-Glucan reduced predicted biological age in a dose-dependent manner, with the highest concentration showing an effect comparable to the CR positive control. Trait-level decomposition revealed a distinct biological-age signature to CR, mainly associated with reproduction, followed by motility and the intestine.

References:

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