PRO-PLANT

Fermented Ocean Fish-XX Foliar Spray

Comprehensive Nutrient & Bioactive Compound Profile

Purpose: This report details the full spectrum of macro-nutrients, micro-nutrients, trace elements, amino acids, vitamins, enzymes, bioactive compounds, and microbial constituents found in Pro-Plant — a foliar spray produced by fermenting ocean Fish-XX fish. **The type of fish has been replaced with Fish-XX.**

1. Overview of Fermented Fish Foliar Sprays

Pro-Plant is classified as a Fish Amino Acid (FAA) product, a biostimulant category rooted in Korean Natural Farming (KNF) and regenerative agriculture. When whole or processed Fish-XX are fermented — typically with a sugar source — the proteins, fats, and cellular components break down into a concentrated liquid rich in bioavailable nutrients. Because it is applied as a foliar spray, nutrients are absorbed directly through leaf stomata, enabling rapid uptake that bypasses soil chemistry entirely.

The cold fermentation process preserves heat-sensitive compounds (vitamins, enzymes, and hormonal precursors) that would be destroyed in heat-processed fish emulsions, resulting in a broader, more bioactive nutrient profile.

2. Major (Macro) Nutrients

The NPK profile of fermented Fish-XX is modest but important, especially for nitrogen delivery during vegetative growth.

Nutrient	Role in Plants & Notes
Nitrogen (N)	Primary macro-nutrient. Fish-XX is protein-dense (~20 g/100g), so fermentation releases abundant organic nitrogen in the form of amino acids, peptides, and ammonium. Drives chlorophyll production, leaf expansion, and vegetative growth.
Phosphorus (P)	Present in fish bones, scales, and cellular membranes as phospholipids. Essential for root development, energy transfer (ATP), and flower/fruit set.
Potassium (K)	Found in fish tissue in meaningful amounts. Regulates stomatal opening/closing, water use efficiency, enzyme activation, and fruit quality.

Carbon (C)	Fermentation produces organic carbon compounds that feed soil microbial communities when the spray drips to the soil, improving nutrient cycling and organic matter.
Sulfur (S)	Present in sulfur-containing amino acids (cysteine, methionine). Involved in enzyme function, protein synthesis, and chlorophyll formation.

3. Secondary Macro-Minerals

Mineral	Role in Plants & Notes
Calcium (Ca)	Abundant in Fish-XX bones and scales. Essential for cell wall structure, cell division, membrane integrity, and disease resistance.
Magnesium (Mg)	Present in fish muscle tissue. Central atom of chlorophyll; critical for photosynthesis and enzyme activation.
Sodium (Na)	Present in fish tissue (Na > Ca in Fish-XX mineral order). Involved in cell membrane balance; minor role in some plant species.

4. Micro-Nutrients

Fish-XX is a naturally rich source of the following micro-nutrients, all of which transfer into the fermented liquid:

Micro-Nutrient	Role in Plants & Notes
Iron (Fe)	Detected in Fish-XX muscle (Fe is highest trace mineral in Fish-XX). Required for chlorophyll synthesis, enzyme activity, and electron transport in photosynthesis.
Manganese (Mn)	Present in Fish-XX tissue. Activates enzymes in photosynthesis (oxygen-evolving complex), nitrogen metabolism, and carbohydrate synthesis.
Zinc (Zn)	Naturally rich in Fish-XX. Required for auxin (growth hormone) synthesis, enzyme activation, protein synthesis, and pollen viability.
Iodine (I)	Present in Fish-XX, an ocean-sourced fish. Emerging evidence suggests iodine may improve plant stress tolerance and antioxidant activity.
Selenium (Se)	Fish-XX fillet provides ~76% of the DRI for humans. In plants, selenium functions as an antioxidant and may reduce heavy-metal stress.
Copper (Cu)	Trace amounts. Required for lignin synthesis, enzyme activation (cytochrome oxidase), and pollen formation.
Boron (B)	Trace amounts from ocean water bioaccumulation. Critical for cell wall synthesis, pollen germination, and sugar transport.
Molybdenum (Mo)	Trace. Required for nitrogen fixation (nitrogenase enzyme) and nitrate reductase activity.

5. Amino Acids

This is the star category of fermented Fish-XX. Fish-XX protein is described as 'complete' — containing all essential amino acids in good proportions. The fermentation process breaks these proteins down into free L-form amino acids that are directly bioavailable to plants through foliar absorption.

5.1 Essential Amino Acids (cannot be synthesized by plants in sufficient quantity)

Amino Acid	Concentration in Fish-XX	Key Plant Benefit
Lysine	Highest EAA (~1.66–1.74 g/100g)	Protein synthesis, seed development, nitrogen metabolism
Leucine	~1.47–1.56 g/100g	Protein synthesis, stress response, enzyme regulation
Arginine	High	Stimulates plant growth hormones (auxins, cytokinins), nitric oxide signaling, root development
Proline	Significant	Critical stress protectant; triggers the proline pathway which stimulates cytokinin & auxin biosynthesis — directly linked to root & shoot vigor
Glutamic Acid	Highest overall (~2.88–3.07 g/100g)	Central hub of nitrogen metabolism; activates nutrient uptake enzymes
Valine	Moderate	Branched-chain amino acid; protein synthesis and stress mitigation
Isoleucine	Moderate	Protein synthesis, energy metabolism
Methionine	Present	Ethylene precursor, methylation reactions, stress response
Phenylalanine	Present	Precursor to lignin, flavonoids, and plant defense compounds (phenylpropanoid pathway)
Threonine	Present	Protein synthesis, immune response, stress tolerance
Tryptophan	Present	Precursor to auxin (IAA) — a key plant growth hormone; also involved in immune tolerance
Histidine	Present	Metal chelation (helps transport zinc, copper), enzyme active sites

5.2 Non-Essential Amino Acids (still biologically active and beneficial)

Amino Acid	Presence	Key Plant Benefit
Aspartic Acid	~1.72–1.84 g/100g — high	Nitrogen assimilation, energy metabolism (TCA cycle)

Glycine	Present	Antioxidant (glutathione precursor), chelating agent improving micronutrient uptake
Serine	Present	Cell membrane phospholipid synthesis, one-carbon metabolism
Alanine	Present	Carbon/nitrogen balance, energy metabolism under stress
Tyrosine	Present	Precursor to plant hormones, stress response
Cysteine	Present	Antioxidant (glutathione synthesis), sulfur storage, enzyme function
Glutamine	Present	Primary nitrogen transport molecule in plants; fuels root growth
Asparagine	Present	Long-distance nitrogen transport, storage
Taurine	Present (fish-specific)	Antioxidant, membrane stabilizer; modulates stress responses
Hydroxyproline	Present (collagen-derived)	Cell wall structural integrity, stress tolerance

Key Insight: The dominance of glutamic acid and aspartic acid is particularly valuable — these are the primary nitrogen carriers in plant metabolism, directly fuelling rapid vegetative growth when delivered via foliar spray.

6. Vitamins

Cold fermentation preserves the heat-sensitive vitamin content of Fish-XX, delivering a broad vitamin profile directly to plant tissue.

Vitamin	Plant Benefit
Vitamin B1 (Thiamine)	Enzyme cofactor; supports root growth, carbon metabolism, and stress resistance. Acts as a plant biostimulant when applied foliarly.
Vitamin B2 (Riboflavin)	Electron carrier in photosynthesis and respiration. Involved in flavonoid biosynthesis and blue-light signaling.
Vitamin B3 (Niacin)	Fish-XX is a very good source (~24% RDA). Cofactor in redox reactions (NAD+/NADH); critical for energy metabolism and stress response.
Vitamin B6 (Pyridoxine)	Coenzyme in amino acid and chlorophyll biosynthesis. Antioxidant; helps regulate plant immune responses.
Vitamin B12 (Cobalamin)	Present in Fish-XX. Rare in plant fertilizers. May support soil microbiome health (some bacteria require B12).
Vitamin D3 (Cholecalciferol)	Present in fish. Emerging research suggests it may influence plant calcium signaling and root hormone activity.

Vitamin E (Tocopherols)	Potent antioxidant. Protects plant cell membranes from oxidative stress; important during high-temperature or drought stress.
Omega-3 Fatty Acids (as precursors)	Fish-XX contains PUFA including linolenic acid (17–22%). In plants, omega-3 fatty acids are precursors to defense hormones (jasmonic acid) — triggering pest and disease resistance.

7. Bioactive Peptides & Proteins

Beyond individual amino acids, fermentation produces short-chain peptides (2–20 amino acids) that have documented biostimulant activities in plants:

- **Auxin-like peptides:** Stimulate cell elongation, root initiation, and apical dominance.
- **Gibberellin-mimicking peptides:** Promote stem elongation, seed germination, and fruit set.
- **Cytokinin-like peptides:** Stimulate cell division, delay senescence (leaf aging), and promote bud formation.
- **Elicitor peptides:** Trigger systemic acquired resistance (SAR) — the plant's immune system — against fungal and bacterial pathogens.
- **Nitrogen-releasing peptides:** Serve as slow-release nitrogen that microbes in soil or on leaves gradually mineralize.

8. Enzymes

Fermentation produces a cocktail of biologically active enzymes, particularly relevant for soil health when spray runoff reaches the root zone:

- Proteases — break down proteins into amino acids, liberating further nitrogen
- Lipases — hydrolyze fats into fatty acids and glycerol
- Amylases — break down complex carbohydrates
- Phosphatases — release bound phosphorus from organic matter, increasing plant availability
- Cellulases — help decompose organic matter in soil, improving structure
- Oxidases — involved in electron transport and antioxidant reactions

9. Fatty Acids & Lipids

Fish-XX contains a diverse lipid profile with compounds that, in fermented form, contribute to plant health:

Fatty Acid / Lipid	Plant-Relevant Activity
Palmitic Acid (C16:0)	Structural component; precursor to cuticle wax that reduces water loss
Elaidic Acid (monounsaturated)	Membrane fluidity; plant stress adaptation

Linolenic Acid (ω-3)	Precursor to jasmonic acid (JA) — the plant's primary defense and wounding hormone
Linoleic Acid (ω-6)	Cell membrane component; precursor to signaling lipids
Phospholipids	Membrane building blocks; directly contribute to phosphorus and carbon nutrition
Glycerol	Produced during fermentation of fats; used in plant osmoprotection under stress

10. Microbial Components — Probiotics & Prebiotics

10.1 Probiotic Microorganisms (Live Beneficial Bacteria)

Fermentation of Fish-XX naturally cultivates a community of beneficial microorganisms. When applied as a foliar spray, these inoculate the phyllosphere (leaf surface microbiome) and, via runoff, the rhizosphere (root zone):

- **Lactobacillus spp.** — lactic acid bacteria that produce organic acids, suppress pathogens, and solubilize nutrients
- **Bacillus spp.** — spore-forming bacteria that produce plant growth hormones, enzymes, and anti-fungal compounds; well-documented as biocontrol agents
- **Pediococcus spp.** — lactic acid fermenters that produce bacteriocins (natural antibiotics) against plant pathogens
- **Saccharomyces cerevisiae (wild yeast)** — produces B vitamins, enzymes, and growth factors; supports soil microbiome diversity

10.2 Prebiotic Compounds

The fermented liquid contains organic compounds that selectively feed beneficial microorganisms in the phyllosphere and rhizosphere:

- **Short-chain fatty acids (SCFAs):** Fermentation by-products (acetate, propionate, butyrate) that feed beneficial microbes and suppress pathogens
- **Oligopeptides:** Small protein fragments that preferentially feed beneficial bacteria over pathogens
- **Organic acids (lactic, acetic):** Maintain a slightly acidic pH that favors mycorrhizal fungi and nitrogen-fixing bacteria
- **Soluble carbon fractions:** Feed soil microbial communities, enhancing nutrient cycling and humus formation

11. Plant Growth Hormones & Precursors

One of the most agriculturally significant aspects of fermented fish is the presence of hormone precursors and hormone-like peptides:

Compound	Hormonal Activity
Tryptophan → Indole-3-Acetic Acid (IAA/Auxin)	Tryptophan is the direct precursor to auxin, the primary rooting and cell elongation hormone. Fermentation can produce free IAA directly.
Proline pathway activators	Elevated proline in the fermentate directly stimulates cytokinin and auxin biosynthesis via the pentose phosphate and shikimate pathways.
Arginine	Precursor to polyamines (putrescine, spermidine) that regulate cell division, stress responses, and fruit development.
Glutamic acid / Glutamine	Regulate nitrogen sensing and signaling, modulating growth hormone pathways.
Cytokinin-like peptides	Delay leaf senescence, stimulate shoot and bud growth, and promote cell division.
Fatty acid-derived jasmonates	Omega-3 fatty acids are precursors to jasmonic acid — a key stress and defense hormone.

12. Antioxidants

Fermented Fish-XX delivers a range of antioxidant compounds that help plants manage oxidative stress from heat, drought, UV radiation, and pathogen attack:

- Taurine — fish-specific antioxidant amino acid
- Selenium compounds — glutathione peroxidase cofactor, major cellular antioxidant
- Vitamin E (tocopherols) — membrane-protective antioxidant
- Vitamin C precursors — supports ascorbate-glutathione cycle
- Cysteine → Glutathione — master cellular antioxidant tripeptide
- Glycine → Glutathione — co-substrate for glutathione synthesis
- Zinc (Zn) — cofactor for superoxide dismutase (SOD), the plant's primary antioxidant enzyme

13. Organic Acids Produced by Fermentation

The fermentation process generates organic acids that have direct plant and soil benefits:

Organic Acid	Benefit
Lactic acid	Suppresses harmful bacteria and fungi on leaf surfaces; slightly acidifies foliar pH for better nutrient absorption
Acetic acid	Antimicrobial; at diluted concentrations promotes root growth
Glutamic acid	Nitrogen shuttle; enzyme activator; umami compound that may attract beneficial insects
Aspartic acid	Central to nitrogen metabolism and energy production (TCA cycle)
Short-chain fatty acids	Feed soil microbiome, improve soil aggregate stability

14. Additional Documented Benefits for Plants

Beyond nutrient delivery, Pro-Plant as a fermented Fish-XX foliar spray provides these documented plant-health benefits:

- **Insect Deterrence:** The amino acid profile and slight fermentation odour repels soft-bodied insects including spider mites, worm moths, and some aphids when applied foliarly.
- **Systemic Acquired Resistance (SAR):** Elicitor peptides and organic acids prime the plant's immune system, improving resistance to fungal and bacterial diseases.
- **Stomatal Regulation:** Potassium, together with glutamic acid, optimizes stomatal opening, improving gas exchange and water use efficiency.
- **Chlorophyll Boost:** Nitrogen, magnesium, iron, and B vitamins collectively increase chlorophyll density, resulting in deeper green colour and improved photosynthesis.
- **Rapid Foliar Absorption:** Free L-amino acids and small peptides pass directly through leaf stomata — a faster delivery system than soil application for correcting deficiencies.
- **Microbiome Inoculation:** Live fermentation microbes colonize the phyllosphere, competing with and suppressing pathogenic organisms.
- **Stress Tolerance:** Proline, glycine betaine precursors, selenium, vitamin E, and omega-3 derivatives work synergistically to improve tolerance to heat, drought, salinity, and heavy metals.
- **Soil Carbon Sequestration:** Organic carbon from spray runoff feeds soil microbiomes, contributing to humus formation and long-term soil fertility.

15. Summary: Complete Compound Profile at a Glance

Category	Compounds
Major Nutrients (NPK)	Nitrogen (N), Phosphorus (P), Potassium (K), Carbon (C), Sulfur (S)
Secondary Macro-Minerals	Calcium (Ca), Magnesium (Mg), Sodium (Na)
Micro-Nutrients	Iron (Fe), Manganese (Mn), Zinc (Zn), Iodine (I), Selenium (Se), Copper (Cu), Boron (B), Molybdenum (Mo)
Essential Amino Acids (10)	Lysine, Leucine, Arginine, Proline, Valine, Isoleucine, Methionine, Phenylalanine, Threonine, Tryptophan, Histidine
Non-Essential Amino Acids	Glutamic Acid, Aspartic Acid, Glycine, Serine, Alanine, Tyrosine, Cysteine, Glutamine, Asparagine, Taurine, Hydroxyproline
Vitamins	B1, B2, B3, B6, B12, D3, Vitamin E (tocopherols)
Fatty Acids / Lipids	Palmitic acid, Elaidic acid, Linolenic acid (ω-3), Linoleic acid (ω-6), Phospholipids, Glycerol
Bioactive Peptides	Auxin-like, cytokinin-like, gibberellin-mimicking, elicitor peptides
Enzymes	Proteases, Lipases, Amylases, Phosphatases, Cellulases, Oxidases
Growth Hormone Precursors	IAA/Auxin (from Trp), Cytokinins (from Pro pathway), Jasmonates (from ω-3), Polyamines (from Arg)

Probiotic Microbes	Lactobacillus spp., Bacillus spp., Pediococcus spp., Saccharomyces cerevisiae
Prebiotic Compounds	Short-chain fatty acids, Oligopeptides, Organic acids, Soluble carbon
Antioxidants	Taurine, Selenium, Vitamin E, Cysteine/Glutathione, Zinc-SOD cofactor
Organic Acids	Lactic acid, Acetic acid, Glutamic acid, Aspartic acid, Short-chain fatty acids

Research Notes

Exact concentrations of each compound will vary based on the age, diet, and parts of the Fish-XX used, the fermentation period and temperature, the sugar source ratio, and the dilution rate at application. The compounds listed represent the documented profile of fermented ocean Fish-XX based on Fish-XX nutritional science and FAA fermentation research. Probiotic activity may vary depending on storage conditions and time since fermentation.

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