

| Supplementary File Table S1. The relationship between supplementation to fish diet with growth, haematological parameters, blood performance, and immune system. | | | | | | | | | | | | | | | | | |
|--|----|----|----|---|---|---|---|----|----|----|----|---|--------------------|-----------|---|---------------------|-----------|
| nt me le pp Su | Ha | Ha | Re | W | M | M | M | To | Bl | Gr | Ly | A | es | ect Sp | Size | nt me m Co | Re fer |
| Barberry root | ↑ | ↑ | ↑ | ↑ | ↓ | ↓ | ↓ | ↑ | @ | ↑ | ↑ | ↑ | Rainbow trout | 16 | | | [24] |
| Garlic | ↑ | ↑ | ↑ | ↑ | ↓ | ↓ | ↓ | ↑ | ↑ | ↑ | ↑ | ↑ | Rainbow trout | 8 | | | [25] |
| Purslane (1.5%) | ↑ | ↑ | ↑ | ↑ | ↓ | ↓ | ↓ | ↑ | ↑ | ↑ | ↑ | ↑ | Rainbow trout | 3 | | | [46] |
| Ashwagandha+ vit c (1%) | ↑ | ↑ | ↑ | ↑ | ↓ | ↓ | ↓ | ↑ | ↑ | @ | - | @ | Rohu | 10 | Mitigates the effect of low pH and waterborne iron toxicity | | [107] |
| Curcumin (1%,2% 3%) | ↑ | ↑ | ↑ | ↑ | - | - | - | ↑ | ↑ | ↑ | ↑ | @ | Rainbow trout | 31 | In all three dosages, improvement was observed | | [47] |
| Ellagic acid | ↑ | ↑ | ↑ | ↑ | - | - | - | ↑ | ↑ | ↑ | ↑ | @ | Rainbow trout | 33 | | | [57] |
| Zeolite (4%) | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | Snakehead murrel | 34 | | | [69] |
| Bitter lemon peels (5%) | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | @ | Ningu | 21 | | | [41] |
| Garlic | - | - | - | - | - | - | - | ↑ | ↑ | ↑ | ↑ | @ | Brown trout | 19 | | | [29] |
| Brewer's yeast (1.5%) | - | - | ↑ | ↑ | - | - | - | - | ↑ | ↑ | @ | @ | Nile tilapia | 6 | | | [31] |
| Brewer's yeast | - | - | - | - | - | - | - | - | ↑ | ↑ | @ | @ | Beluga | 11 | | | [32] |
| (Oak acorn, coriander, and common mallow) | - | ↑ | ↑ | - | ↑ | ↓ | ↓ | ↑ | ↑ | ↑ | ↑ | ↑ | Common carp | 20 | | | [58] |
| Butyric acid glycerides (1%) | ↑ | ↑ | ↑ | ↑ | - | - | - | ↑ | ↑ | ↑ | ↑ | ↑ | Yellowfin seabream | 9 | | | [59] |
| Prebiotic inulin (15 g/kg) | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | - | -- | ↑ | ↑ | @ | Asian seabass | 7 | | | [48] |
| EDTA (1.5%, 1% and 2%) | - | - | - | - | - | - | - | - | ↑ | @ | @ | @ | Beluga | 38 | Mitigates the heavy metal stress | | [15] |
| Beet molasses (2%) | ↑ | ↑ | ↑ | ↑ | - | - | - | ↑ | ↑ | @ | ↑ | @ | Common carps | 20 | Mitigates copper nano oxide stress | | [90] |
| Roselle anthocyanin (1%) | ↑ | ↑ | ↑ | - | - | - | - | - | ↑ | - | ↑ | ↑ | Rainbow trout | 14 | | | [60] |
| Key lime and <i>bacillus licheniformis</i> (3%) | - | - | - | ↑ | - | - | - | ↑ | ↑ | ↑ | ↑ | @ | Common carp | 45 | | | [118] |
| Butyric acid (5 g/kg) | ↑ | - | - | ↑ | ↓ | - | - | ↑ | ↑ | ↑ | ↑ | @ | Barramundi | 12 | | | [26] |
| Exopolysaccharide | ↑ | ↑ | ↑ | - | - | - | - | - | ↑ | ↑ | @ | @ | Red hybrid tilapia | 16 | | | [27] |
| Ginger extract (0.2%) | ↑ | ↑ | ↑ | ↑ | - | - | - | ↑ | ↑ | ↑ | ↑ | ↑ | Common carp | 11 | | | [113] |
| Thyroxine t4 | ↑ | ↑ | ↑ | ↑ | - | - | - | ↑ | ↑ | ↑ | @ | @ | Sterlet sturgeon | 78 | | | [49] |
| Coriander extract (2%) | ↑ | ↑ | - | - | - | - | - | - | ↑ | ↑ | ↑ | @ | Rainbow trout | 62 | | | [61] |
| Exogenous enzymes + probiotics | ↑ | ↑ | ↑ | ↓ | - | - | - | ↑ | ↑ | ↑ | ↑ | @ | Siberian sturgeon | 138 | | | [28] |
| Chitosan nanoparticles (0.5%) | ↑ | ↑ | ↑ | ↑ | ↑ | - | - | ↑ | ↑ | ↑ | @ | @ | Nile tilapia | 6 | | | [78] |
| Nanoparticulate Fu+Cu | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | - | ↓ | ↑ | ↑ | ↑ | ↑ | Snow trout | 24 | | | [84] |
| High carbohydrate + cinnamon | - | - | - | - | - | - | - | ↓ | ↓ | ↓ | @ | @ | Rainbow trout | 16 | | | [16] |
| Benzoic acid 0.1% | ↑ | - | - | - | - | - | - | - | ↑ | ↑ | @ | @ | Nile tilapia | 6 | | | [52] |
| Macroalga <i>Sargassum angustifolium</i> | ↑ | ↑ | ↑ | ↑ | - | ↑ | ↑ | ↑ | ↑ | ↑ | - | - | Rainbow trout | 7 | | | [50] |
| Bulk selenium and nano selenium 0.8 mg/kg | ↑ | ↑ | ↑ | ↑ | - | - | - | - | ↑ | ↑ | ↑ | @ | Nile tilapia | 5 | both showed a same trend | | [83] |
| Sodium Acetate +sodium propionate | ↑ | - | - | - | - | - | - | ↑ | ↑ | ↑ | ↑ | ↑ | Yellowfin seabream | 6.5 | | | [108,15] |
| wood betony extract (8%) | ↑ | - | - | ↑ | - | - | - | - | ↑ | ↑ | @ | @ | Rainbow trout | 16 | | | [53] |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---------------------|----|--|-------|
| B-glucan | - | - | - | - | - | - | - | - | ↑ | ↑ | ↑ | ↑ | @ | Nile tilapia | 10 | | [62] |
| Triticale plant 20% in diet | - | - | - | - | - | - | - | - | - | - | - | - | @ | Nile tilapia | 14 | | [93] |
| Sodium alginate+ probiotic <i>p. Acidilactici</i> | - | - | ↑ | ↑ | - | - | - | - | ↑ | ↑ | ↑ | ↑ | @ | Asian sea bass | 12 | | [80] |
| Olive leaf extract | ↑ | ↑ | ↑ | ↑ | - | - | - | - | ↑ | ↑ | ↑ | ↑ | @ | Common carp | 32 | | [114] |
| Vaccinated fish +probiotic <i>L. plantarum</i> | ↑ | - | - | ↑ | - | - | - | - | ↑ | ↑ | ↑ | ↑ | ↑ | Rainbow trout | 29 | | [117] |
| Carvacrol (1%) | - | - | - | ↑ | - | - | - | - | ↑ | ↑ | ↑ | ↑ | @ | Tambaqui | 72 | | [30] |
| Common mallow (5%) | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | - | - | ↑ | ↑ | ↑ | ↑ | ↑ | Rainbow trout | 10 | | [112] |
| Stinging nettle | ↑ | ↑ | ↑ | ↑ | @ | @ | @ | - | ↑ | ↑ | ↑ | ↑ | @ | Rainbow trout | 42 | | [116] |
| Polysaccharide (fucoidan) | ↑ | ↑ | ↑ | ↑ | - | - | - | - | ↑ | ↑ | ↑ | ↑ | @ | Nile tilapia | 17 | | [88] |
| Encapsulated probiotic (<i>G. candidum</i>) | ↑ | ↑ | ↑ | ↑ | ↓ | ↓ | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | @ | Rohu | 20 | | [79] |
| Nanoparticulate selenium | ↑ | ↑ | ↑ | ↑ | ↑ | - | - | - | ↑ | ↑ | ↑ | ↑ | @ | Common carp | 10 | | [51] |
| Prebiotic grobiotic®-a | ↑ | ↑ | ↑ | ↑ | - | - | - | - | ↑ | ↑ | ↑ | ↑ | @ | Beluga | 40 | | [91] |
| Soybean lecithin (6%) | ↑ | ↑ | ↑ | ↑ | - | ↓ | - | - | ↑ | ↑ | ↑ | ↑ | ↑ | Stellate sturgeon | 11 | | [89] |
| Rose hip and safflower | - | - | - | ↑ | - | - | - | - | - | ↑ | ↑ | ↑ | ↑ | Beluga | 26 | | [127] |
| n-3 LC-PUFA (1.2%) | ↑ | - | - | - | - | - | - | - | - | ↑ | ↑ | - | @ | Silvery-black porgy | 13 | | [128] |
| Probiotics <i>Enterococcus casseliflavus</i> | ↑ | ↑ | ↑ | ↑ | - | - | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | @ | Rainbow trout | 38 | | [129] |
| Farming in 33 vs 20 degree | - | - | - | - | - | - | - | - | - | ↑ | ↑ | @ | @ | Asian sea bass | 74 | | [123] |
| Tarragon | ↓ | ↓ | ↓ | ↑ | ↓ | ↑ | ↑ | ↑ | ↑ | - | - | ↑ | @ | Rainbow trout | 7 | | [130] |

MCV: mean corpuscular volume; MCH: mean corpuscular haemoglobin; MCHC: mean corpuscular haemoglobin concentration, ACH50: serum alternative complement activity. The upwards and downward arrows show the significant increase and decrease, respectively in the treatment with the highest growth as compared with control according to the Independent Samples T-Test ($P < 0.05$). The minus sign shows no significant difference between control and treatment with the highest growth. For providing three replicates for analysis, two random numbers were generated with Excel based on the reported average and standard deviation. At sign (@) shows the parameter was not reported in the article.

$$\text{Blood performance (BP)} = \text{Ln (Hb (g/dl))} + \text{Ln Ht (\%)} + \text{Ln RBC (*10}^5/\text{mm}^3) + \text{Ln WBC (*10}^3/\text{mm}^3) + \text{Ln TP (g/l)}$$

| Supplementary File Table S2. The relationship between supplementation to fish diet with growth, haematological parameters, blood performance, and immune system under different stressful situations. | | | | | | | | | | | | | | | | | |
|---|----|----|----|---|---|---|---|----|----|----|---|-----------------|----|----|-----|----------------------|-------|
| Stressor | Ha | Ha | Re | W | M | M | M | To | Bl | Ly | A | es | ed | Sp | e | Siz | nt |
| Ammonia stress | ↓ | - | - | ↓ | ↑ | ↓ | ↓ | ↓ | ↓ | | | Rainbow trout | | | 8 | | [25] |
| Atrazine (4 ppm) | ↓ | ↓ | ↓ | ↓ | ↑ | ↓ | - | ↓ | ↑ | @ | @ | Snow trout | | | @ | | [106] |
| Low Temperature (22 vs 30) | ↓ | ↓ | ↓ | ↓ | - | - | - | - | ↓ | @ | @ | Snapper | | | 167 | | [38] |
| Microplastics (15 Days, 10 mg/L) | ↓ | ↓ | ↓ | ↓ | ↑ | ↑ | ↓ | ↑ | ↓ | @ | @ | Nile tilapia | | | @ | | [39] |
| Silver nanoparticles | - | ↓ | ↓ | - | - | - | ↑ | ↓ | ↓ | ↓ | ↓ | Common carp | | | 9 | 21 days, 50% of LC50 | [66] |
| Praziquantel | ↓ | ↓ | ↓ | ↑ | - | - | - | ↓ | ↓ | @ | @ | African catfish | | | 34 | | [40] |
| Silver nanoparticles (0.4 mg/l) | ↓ | ↓ | ↑ | ↑ | ↓ | ↓ | ↑ | ↓ | ↓ | @ | @ | Rainbow trout | | | 250 | | [73] |
| Ammonia exposure in 19 c (1mg/l) | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | @ | @ | Rockfish | | | 38 | 4 Weeks | [37] |
| <i>Aeromonas hydrophila</i> | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | @ | Ningu | | | 21 | | [41] |
| Herbicides butachlor | ↓ | ↓ | ↓ | ↑ | - | - | - | ↓ | ↓ | @ | @ | Common carp | | | 8 | | [72] |
| Herbicides oxadiazon | ↓ | ↓ | ↓ | ↑ | ↑ | ↑ | - | - | ↓ | @ | @ | Common carp | | | 8 | | [72] |

| | | | | | | | | | | | | | | | |
|--|---|---|---|---|---|---|---|---|---|---|---|-------------------|-----|---|-------|
| <i>Aeromonas hydrophila</i> | ↓ | ↓ | – | ↑ | – | ↑ | ↓ | ↓ | ↓ | ↓ | @ | Goldfish | 47 | | [63] |
| Endosulfan 96 h LC50 | – | ↓ | – | ↑ | – | – | – | ↓ | ↓ | ↓ | @ | African catfish | 65 | | [131] |
| <i>Vibrio alginolyticus</i> | – | – | – | – | ↓ | ↓ | ↓ | – | ↓ | – | @ | Longtooth grouper | 26 | | [64] |
| The LC50- 96h Crude Oil | ↓ | ↑ | ↓ | ↓ | ↑ | – | ↓ | ↓ | ↓ | @ | @ | Beluga | 8 | | [105] |
| Clotrimazole 7.76 mg/l | ↓ | ↓ | ↓ | ↓ | ↓ | ↑ | ↑ | ↓ | ↓ | @ | @ | African catfish | 27 | | [99] |
| Feed restriction | – | – | – | – | – | ↓ | ↑ | ↑ | ↓ | @ | @ | Siberian sturgeon | 54 | Decreased growth | [65] |
| Hg (0.13 ppm) | ↓ | ↓ | ↓ | – | – | – | – | ↓ | ↓ | ↓ | @ | African catfish | 80 | | [43] |
| UVA-induced | ↓ | – | ↓ | – | – | – | – | – | ↓ | @ | @ | African catfish | 180 | <i>Spirulina Platensis</i> mitigated stress | [75] |
| Polyethylene microparticles (5%) | – | ↓ | – | ↓ | – | – | – | – | ↓ | @ | @ | Rainbow trout | 89 | | [109] |
| Atrazine herbicides | ↓ | ↓ | ↓ | ↓ | – | – | – | ↓ | ↓ | @ | @ | Nile tilapia | 17 | Fucoidan mitigated stress | [88] |
| Grass carp reovirus | ↓ | ↓ | ↓ | ↓ | – | – | – | ↑ | ↓ | @ | @ | Grass carp | 25 | | [42] |
| Methyl mercury chloride toxicant | ↓ | – | ↓ | ↓ | – | – | – | ↓ | ↓ | @ | @ | Nile tilapia | 23 | Decreased growth | [70] |
| Fungal t-2 toxin | ↓ | ↓ | ↓ | ↓ | – | – | – | – | ↓ | @ | @ | Common carp | 77 | | [100] |
| Phosalone (0.3 mg/l) | ↓ | ↓ | ↓ | ↓ | ↑ | ↑ | ↑ | – | ↓ | ↓ | @ | Common carp | 35 | | [132] |
| Pharmaceutical (chronic diclofenac) | ↓ | ↓ | ↓ | – | – | ↑ | ↑ | ↓ | ↓ | @ | @ | African catfish | 30 | 1/16 96 Hours LC50 | [74] |
| Nodavirus like-agent | ↓ | ↓ | ↓ | ↓ | ↑ | – | – | ↓ | ↓ | @ | @ | Mullet | 75 | | [133] |
| Deltamethrin, 35 days | ↓ | ↓ | ↓ | – | ↓ | ↓ | ↓ | ↓ | ↓ | @ | @ | Major carp | 7 | | [134] |
| NPK (15:15:15) fertiliser | ↓ | ↓ | ↓ | ↑ | ↑ | ↓ | ↓ | ↓ | – | @ | @ | African catfish | 32 | | [135] |
| Uranyl acetate | ↓ | ↓ | – | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | @ | @ | African catfish | 55 | | [136] |
| <p>MCV: mean corpuscular volume; MCH: mean corpuscular haemoglobin; MCHC: mean corpuscular haemoglobin concentration, ACH50: serum alternative complement activity. The upwards and downward arrows show the significant increase and decrease, respectively, in the treatment under stress as compared with control according to the Independent Samples T-Test (P<0.05). The minus sign shows no significant difference between control and treatment under stress. For providing three replicates for analysis, two random numbers were generated with Excel based on the reported average and standard deviation. At sign (@) shows the parameter was not reported in the article.</p> <p>Blood performance (BP)= Ln (Hb (g/dl) + Ln Ht (%) + Ln RBC (*10⁵/mm³) + Ln WBC (*10³/mm³) + Ln TP (g/l)</p> | | | | | | | | | | | | | | | |

| Supplementary File Table S3. The relationship between supplementation to fish diet with growth, haematological parameters, blood performance, and immune system in fish meal replacement studies. | | | | | | | | | | | | | | | |
|---|----|----|----|---|---|---|---|----|----|----|----|---|-----------------------|-----|--|
| Supplement | Ha | Ha | Re | W | M | M | M | To | Bl | Gr | Ly | A | es | Sp | nt |
| MBM (65%) | ↓ | ↓ | ↓ | – | ↓ | – | ↓ | – | ↓ | ↓ | ↓ | ↓ | Rainbow trout | 8 | Garlic mitigates negative impacts |
| Insects mean (75%) | – | – | – | – | – | – | – | – | – | – | @ | @ | African catfish | 4 | |
| Total replacement of SBM with plants | – | – | – | – | – | – | – | – | – | – | @ | @ | Nile tilapia | 5 | 35% SBM in diet |
| 70%SBM | – | – | ↓ | – | ↑ | ↑ | – | ↓ | ↓ | ↓ | ↓ | – | Beluga | 351 | |
| 70%SBM+probiotic | – | – | – | – | – | – | – | – | – | – | ↑ | ↑ | Beluga | 351 | |
| Insect meal (20%) | – | – | – | – | – | – | – | – | ↓ | ↓ | – | @ | Nile tilapia | 17 | Up to 15% no difference in growth and BP across treatments |
| Tallow, PBM+tallow+DHA | – | – | – | – | – | – | – | – | – | – | @ | @ | Totoaba | 10 | |
| Macroalgae (<i>Sargassum ilicifolium</i>) | – | – | ↑ | ↑ | – | – | – | – | ↑ | ↑ | ↑ | ↑ | Barramundi | 29 | |
| <i>Spirulina platensis</i> and <i>Chlorella vulgaris</i> | – | ↑ | ↑ | ↑ | – | – | – | ↑ | ↑ | ↑ | @ | @ | African catfish | 42 | Both increased |
| Soybean meal in diet 15% | – | – | – | – | – | – | – | – | – | – | @ | @ | California yellowtail | 58 | |
| vegetable oils | – | – | – | – | – | – | – | – | – | – | @ | @ | African catfish | 5 | |

| | | | | | | | | | | | | | | | | |
|-----------------------------|---|---|---|---|---|---|---|---|---|---|---|---|-------------------|-----|--|-------|
| heat-treated soybean meal | ↓ | - | - | - | - | - | ↓ | - | - | - | @ | - | Siberian sturgeon | 190 | | [125] |
| 50% unrefined peanut oil | - | ↑ | - | - | ↑ | - | ↓ | - | - | - | @ | @ | Seabream | 10 | | [121] |
| Faba bean meal 10% | - | - | - | - | - | - | - | - | - | - | @ | @ | Beluga | 82 | | [104] |
| Faba bean meal 25% | - | - | - | - | - | - | - | - | ↓ | ↓ | @ | @ | Beluga | 82 | | [104] |
| Dry olive cake 12% | - | - | - | - | - | - | - | - | - | - | @ | @ | Hybrid tilapia | 9 | | [122] |
| <i>Jatropha platyphylla</i> | - | ↑ | ↑ | - | - | ↓ | - | - | ↑ | - | @ | @ | Nile tilapia | 14 | | [137] |
| Soybean meal | - | ↑ | ↑ | - | - | ↓ | - | - | ↑ | - | @ | @ | Nile tilapia | 14 | | [137] |
| Fermented soy pulp 50% | ↑ | - | ↑ | - | - | ↑ | - | ↑ | - | ↑ | @ | @ | African catfish | 8 | | [126] |
| Fermented soy pulp 100% | - | - | ↓ | - | - | - | - | ↑ | - | ↓ | @ | @ | African catfish | 8 | | [126] |
| Yellow mealworm (50%) | - | ↓ | - | - | - | - | - | - | - | - | @ | @ | Rainbow trout | 43 | | [120] |

MCV: mean corpuscular volume; MCH: mean corpuscular haemoglobin; MCHC: mean corpuscular haemoglobin concentration, ACH50: serum alternative complement activity. The upwards and downward arrows show the significant increase and decrease, respectively, in the representative treatment as compared with control according to the Independent Samples T-Test ($P < 0.05$). The minus sign shows no significant difference between control and representative treatment. For providing three replicates for analysis, two random numbers were generated with Excel based on the reported average and standard deviation. At sign (@) shows the parameter was not reported in the article.

$$\text{Blood performance (BP)} = \ln(\text{Hb (g/dl)}) + \ln(\text{Ht (\%)}) + \ln(\text{RBC (*10}^5/\text{mm}^3)) + \ln(\text{WBC (*10}^3/\text{mm}^3)) + \ln(\text{TP (g/l)})$$