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Determination of Mineral Composition of *Catla Catla* Waste and its Impact on Growth of *Eleusina Coracana*

Rayasam Sreedhar[1], Gundala Harold Philip[2]

[1,2]Department of Zoology, Sri Krishnadevaraya University, Anantapuramu, Andhra Pradesh, India

Abstract: ***Fishing in India is a major Industry and fish production has been on the rise since independence. Catching and processing of fish generates significant amount of solid waste which include head, offal, fins, some bones, skin, viscera, roe and scales. In view of the high nutrient value of fish and its waste the waste generated by sale of the fish, Catla catla in Anantapuram market was collected and it wash air dried for fifteen days and made in to fine powder. 50mg, 100mg and 200mg of this waste was mixed with 150gm of soil and in this finger millet (Eleusina coracana) was grown for forty five days. Measurement of growth of finger millet supplemented with varied concentration of waste has increase the growth of plant and its root. Determination of chemical composition of fish waste has shown that this is a rich source of nutrients and micro elements. Our studies have shown that plant with fish waste also have increased amount of nutrients and micro elements. Hence it can be said that waste of Catla catla is a good supplement to improve plant growth, quantitatively and qualitatively.***

Keywords: fish waste, finger millet, nutrients, micro elements

1. Introduction

Fishing and aquaculture in India has a long history. For centuries, India has had a traditional practice of fish culture in small ponds in Eastern India [1] and today fishing in India is a major industry especially in its coastal states, employing over fourteen million people. Fish production in India has increased more than tenfold since its independence in 1947 [2]. According to the Food and Agriculture Organization (FAO) of the United Nations, fish output in India doubled between 1990 and 2010 [2]. Today India is the second largest producer of fish in the world contributing to about 5.43% of global fish production.

Catching and processing of fish generates a significant amount of solid waste, which includes head, tails, viscera, fins and scales [3]. Majority of wastes are produced by on-shore processing and markets. This abundant waste may pose environmental hazard due to the easy deterioration [4]. It is estimated that one million tons of fish wastes are produced annually in India, and of this waste, surimi waste comprises about 2000 tons [5]. The amount of fish wastes (by-products and by-catch) depends on many factors: fish species, size, season and catch methods, processing technique, local regulations, market, etc [6]. Until recently it was common practice to dump fish waste back into the lake or ocean. Most times it was dumped in one place and as a consequence contaminating the aquatic ecosystem quickly. Hence such dumping has been banned [7]. There are several ways to treat fish waste. However, composting fish waste is regarded as a simple, economical and environmentally friendly approach to effective treatment [8].

Fish waste was known to be rich in various components likes fat, protein and proteases [9], [10]. Many researchers have reported the chemical constituent and proteases in viscera from marine fish [11], [12], [13], [14]. Fresh visceral waste of *Catla catla* has considerable protease activity especially neutral proteases [15]. The moisture, protein, fat and ash content of the Alskan Pollock, Pacific cod and pink salmon samples on wet tissue basis are also studied [16]. It was observed that population of Kelp Gull, a sea bird, increased during a decades time after they started feeding on waste generated from fish processing plants [17], [18], [19], [20], [21].

Since fish waste is known to have such high nutrient value its possible role in improving the plant growth, *Eleusine coracana* was tested in the present study. This plant was selected as it is important diet for pregnant women, nursing mother and children. Daily consumption of millets reduces the incidence of cardiovascular disease, duodenal ulcer and hyperglycemia (diabetes) [22].

2. Materials and Method

2.1 Collection and preparation of fish waste

Waste of the Indian major carp *Catla catla* consisting of parts of head, scales, fins, some bones, skin, tails, viscera and roe was collected from local fish market in Anantapuramu. It was dried by exposing to sunlight for fifteen days and was made fine powder using blender.

2.2 Plant

Finger millet (*Eleusine coracana*), is also known as African millet and Ragi in India. It is an important cereal crop for subsistence agriculture in the dry areas of Eastern Africa, India and Srilanka. India is one among the major cereal producing countries in the world. It has a high level of regional or local adaptation. Although grown under dry lands, it provides an assured harvest, thus making it indispensable in specific ecosystems.

2.3 Experimental Design

150gm of red soil was taken in small pots and to it 50mg, 100mg and 200mg of powdered fish waste was added. Seeds of *Eleusine coracana* (Finger millet) was sown in it and grown for forty five days. Length of the plant was measured after 15, 30 and 45 days. Six replicates for each concentration was maintained. After the end of forty five days plant was removed from pot and length of the root was measured.

2.4 Preparation of Plant Material

After forty five days plant material (excluding roots) was dried at room temperature for seven days and then was made in to fine powder using mortar and pestle.

2.5 Analysis of Elements

One gram of powdered plant sample (Finger millet) and waste of *Catla catla* were digested with diacid mixture (Nitric acid and perchloric acid in 10:4 ratios). The digested samples were diluted to known volume with double distilled water and filtered. This filterate was used for the estimation of different elements. Estimation of Nitrogen by microjeldahl [23], Calcium and Magnesium by titrimetric [24], Sulphur by turbidimetric [24], Phosphorus by spectrophotometric [25], Potassium by using flame photometer [25], Iron, Manganese, Copper, and Zinc by Atomic absorption spectrophotometer AAS [24] methods were carried out.

2.6 Statistical Analysis

All the reported data are the means of six replicates ($n = 6$). Significant mean differences were calculated by Duncan's multiple range (DMR) test ($P < 0.05$).

3. Results

3.1 Measurement of Plant Growth

Length of plants and its roots grown in soil different concentration of fish waste were measured (Figure: 1). Control plants grown only in natural soil have grown up to 1.30 ± 0.30 inches (after 15 days), 7.21 ± 1.13 inches (after 30 days) and 13.41 ± 1.35 inches (after 45 days). After addition of 50mg of fish waste the growth was 1.85 ± 0.25 inches (after 15 days), 9.70 ± 0.71 inches (after 30 days) and 16.08 ± 1.49 inches (after 45 days). After addition of 100mg of fish waste the growth was 1.53 ± 0.10 inches (after 15 days), 9.56 ± 0.29 inches (after 30 days) and 16.33 ± 0.28 inches (after 45 days). After addition of 200mg of fish waste the growth was 4.06 ± 0.20 inches (after 15 days), 9.43 ± 0.23 inches (after 30 days) and 17.96 ± 0.26 inches (after 45 days). Plants grown in soil containing 50mg, 100mg and 200mg of fish waste have shown significant increase in growth after 15, 30 and 45days. The length of root after 45days was 7.23 ± 0.44 inches (control), 8.13 ± 0.39 inches (50mg), 7.58 ± 0.28 inches (100mg) and 7.66 ± 0.20 (200mg).

3.2 Concentration of Nutrients

Concentration of different nutrients were determined in fish waste and whole plant grown of soil supplemented with different concentration of fish waste (Figure: 2). Nitrogen was found to be 65.6 ± 0.23µg gm^{-1}in fish waste. Whereas plant material had 17.7 ± 0.29µg gm^{-1} (control), 18.2 ± 0.26µg gm^{-1} (50mg), 19.2 ± 0.18µg gm^{-1} (100mg) and 24.2 ± 0.17µg gm^{-1} (200mg). Phosphorus was found to be 14.31 ± 0.02µg gm^{-1}in fish waste. Whereas plant material had 2.65 ± 0.02µg gm^{-1} (control), 3.05 ± 0.02 µg gm^{-1} (50mg), 3.25 ± 0.02 µg gm^{-1} (100mg) and 2.84 ± 0.02 µg gm^{-1} (200mg). Potassium was found to be 3.51 ± 0.02µg gm^{-1}in fish waste. Whereas plant material had 23.90 ± 0.02µg gm^{-1} (control), 29.80 ± 0.03µg gm^{-1} (50mg), 29.90 ± 0.02µg gm^{-1} (100mg) and 26.82 ± 0.03µg gm^{-1} (200mg). Sulphur was found to be 12.3 ± 0.18µg gm^{-1}in fish waste. Whereas plant material had 10.6 ± 0.23µg gm^{-1} (control), 13.1 ± 0.20µg gm^{-1} (50mg), 11.5 ± 0.31µg gm^{-1} (100mg) and 11.9 ± 0.20µg gm^{-1} (200mg). Calcium was found to be 58.40 ± 0.03µg gm^{-1}in fish waste. Whereas plant material had 6.40 ± 0.04µg gm^{-1} (control), 12.40 ± 0.03µg gm^{-1} (50mg), 8.80 ± 0.02µg gm^{-1} (100mg) and 9.20 ± 0.03µg gm^{-1} (200mg). Magnesium was found to be 5.76 ± 0.03µg gm^{-1}in fish waste. Whereas plant material had 1.92 ± 0.03µg gm^{-1} (control), 2.64 ± 0.02µg gm^{-1} (50mg), 2.40 ± 0.03µg gm^{-1} (100mg) and 2.16 ± 0.03µg gm^{-1} (200mg). Levels of nutrients in plant material grown in soil supplemented with different concentration fish waste have shown significant increase over control ($P<0.05$).

3.3 Concentration of Micro Elements

Concentration of different micro elements were also determined in fish waste and plants (after 45 days) grown in pots containing different concentration of fish waste (Figure: 3). Fish waste contained 0.48 ± 0.02µg gm^{-1} concentration of copper. Plant material grown soil alone contains 0.23 ± 0.02µg gm^{-1} copper. Its concentration increased to 0.30 ± 0.03µg gm^{-1} as a result of supplementing with 50mg of fish waste, 0.22 ± 0.03µg gm^{-1} as a result of supplementing with 100mg of fish waste and 0.29 ± 0.03µg gm^{-1} as a result of supplementing with 200mg of fish waste. Fish waste contained 5.98 ± 0.04µg gm^{-1} concentration of ferrous. Plant material grown soil alone contains 2.74 ± 0.04µg gm^{-1}ferrous. Its concentration increased to 4.51 ± 0.02µg gm^{-1} as a result of supplementing with 50mg of fish waste, 4.22 ± 0.02µg gm^{-1} as a result of supplementing with 100mg of fish waste and 2.82 ± 0.03µg gm^{-1} as a result of supplementing with 200mg of fish waste. Fish waste contained 0.75 ± 0.03µg gm^{-1} concentration of manganese. Plant material grown soil alone contains 0.79 ± 0.02µg gm^{-1} manganese. Its concentration increased to 1.29 ± 0.03µg gm^{-1} as a result of supplementing with 50mg of fish waste, 0.96 ± 0.03µg gm^{-1} as a result of supplementing with 100mg of fish waste and 0.86 ± 0.03µg gm^{-1} as a result of supplementing with 200mg of fish waste. Fish waste contained 3.10 ± 0.02µg gm^{-1} concentration of zinc. Plant material grown soil alone contains 0.33 ± 0.02µg gm^{-1} zinc. Its concentration increased to 0.84 ± 0.02µg gm^{-1} as a result of supplementing with 50mg of fish waste, 0.53 ± 0.03µg gm^{-1} as a result of supplementing with 100mg of fish waste and 0.41 ± 0.03µg gm^{-1} as a result of supplementing with 200mg of fish waste. Levels of micro elements in plant material grown in soil supplemented with different concentration fish waste have shown significant increase over control ($P<0.05$). Except in case of copper of plant grown in pot containing 50 mg of fish waste.

4. Discussion

Various types of supplements at different concentrations are capable of exerting beneficial effects on plants when grown in protected environment. One of the beneficial effect is increased growth of plant. Supplements for this increased growth could be bacteria, minerals and nutrients either alone or in combination. In this study we evaluated the growth of finger millet by supplementing the soil with varied concentrations of waste of the fish, *Catla catla* as this is a good source of nutrients especially of calcium, other minerals and fiber [26]. We observed that this supplement, which is rich in different nutrients (Figure: 2) and micro elements (Figure: 3) have increased the growth of plant. Nutrients are basically two types-macronutrients and micronutrients. Nitrogen, phosphorus and potassium are the primary macronutrients and calcium, magnesium and sulphur are considered secondary macronutrients. Micronutrients are elements that are required in small quantities, but they are essential for the overall performance and health of the plant.

Our results indicated that addition of 50, 100 and 200mg of *Catla catla* waste increased growth of finger millet significantly. This can be attributed to increase in root growth and subsequent increase in the rate of water and minerals uptake. It was shown by different researchers that different nutrients and micro elements contribute to growth of finger millet. Nitrogen when applied individually, or in combination with *Azospirillum* was also found to increase growth of this plant [27]. Maximum ragi plant height was recorded with application of recommended dose of fertilizer along with zinc sulphate (ZnSO4), gypsum and *Azatobacter* fertilizer [28]. Inoculation with *Arbuscular mycorrhizal* (AM) fungi, *Azospirillium brasilense* and *Bacillus polymyxa* produced highest effect on either plant growth or nutrient uptake, together with a noticeable increase in mycorrhizal root colonization [29], [30]. Number of ear heads of finger millet, the finger length and test weight were significantly high in plants receiving fertilizer and farm yard manure (FYM) along with bio fertilizers inoculation [31].

In general fish waste is known to be rich source of minerals compared to other wastes. The physical and chemical composition of fish manure is influenced by several factors like species and size of fish, feed and feeding system, etc. Hence the composition is different in waste collected from different fishes. One of the greatest assets of fish waste is it contains a very high concentration of protein that is 58% of dry matter. This is only slightly lower than the protein content of fish meal that is usually between 60% to 70% dry matter [32], [33]. It was shown earlier that viceral waste of *Catla catla* contain protein content of 8.52%, higher amount of fat (> 12%) and with various degrees of amino acid [34].

It was shown by Esteban et al., (2007) [35] that dry matter of different type of fish waste contains a large variety of macro and micro minerals with concentration of 6% of Calcium, 2% of Phosphorous, 0.7% of Potassium, 0.6% of Sodium, 0.2% of Magnesium, 100 ppm of Iron, 62 ppm of Zinc, 6 ppm of Manganese and 1 ppm of Copper. They have also shown the fat content to be 19% of dry matter, which comprises primarily of monounsaturated acids, palmitic and oleic acid.

Analysis of silage prepared from Spanish mackerel was known to contain 0.1320 mg/kg (0.13%) Potassium, 1895 mg/kg (0.18%) Sodium and 24470 mg/kg (2.44%) Phosphorous [36]. Higher potassium content than mentioned above was reported in acid silage developed from marine fishery waste along with 6.29% of total Nitrogen, 1.03% of Phosphorous, 0.30% of Potassium and 0.05% of Sodium [37]. Various amino acid concentrations- 3.56% of glycine, 3.23% of threonine, 1.67% of alanine, 2.45% of arginine, 0.28% of cystine and 2.34% of tyrosine were also noticed in this silage.

Composition of the nutrients and micro elements found in the waste of *Catla catla* with that of others mentioned above have shown there is not much different with regards to their compostion. Rao et al., (1973) [38] analyzed the mineral content of 15 new ragi varieties and reported fibre content of 3.08 to 5.72 per cent, ash 2.00 to 4.33 per cent, phosphorus 227 to 470 mg/100 g, calcium 203 to 690 mg/100 g and Ferrous 20.9 to 93.5 mg /100 g. Same group in 1994 [39] reported that Indaf-5 (brown) variety had iron content of 12.3 per cent, while in WR (white) variety, the value was 4.4 mg/100g. In this plant (Sridhar and Laxminarayana, 1994) [40] reported total lipid content (Dry matter basis) comprised of free, bound and structural lipids at a concentration of 5.2 per cent. Linoleic acid, oleic acid and palmitic acid were the chief constituent in all the lipid classes. Among all the cereals, ragi was shown to have high calcium (0.70%), phosphorous (0.33%), crude protein (9.13%), crude fibre (3.63%), fat (2.28%), ash (5.11%), tannin (3.42-3.47%).

Proximate composition of raw and processed ragi determined by Gunashree et al., (2014) [41] have shown that crude protein between range 3.1 to 13.5%, total fat range 1.0 to 1.8%, ash range 1.8 to 2.4%, total fibre range 2.02 to 3.66% and moisture range 2 to 8%. This research group have also shown that minerals such as calcium, magnesium, copper, manganese, ferrous, zinc, potassium and sodium to be 280.6, 350, 71, 246, 4.97, 2.56, 5.34, 0.83 mg/100g respectively in raw ragi sample. The composition of nutrients and micro elements observed in *Eleusine coracana* after supplementing with different concentration of waste of *Catla catla* increased with increase in concentration. Hence it can be concluded that whole fish waste of *Catla catla* is a good supplement to improve growth qualitatively of this highly nutritive plant.

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Author Profile

Prof. G. H. Philip, Head and BOS, Department of Zoology, Sri Krishnadevaraya University, Anantapuramu, AP, India.

Mr. R. Sreedhar, Research Scholar, Department of Zoology, Sri Krishnadevaraya University, Anantapuramu, AP, India

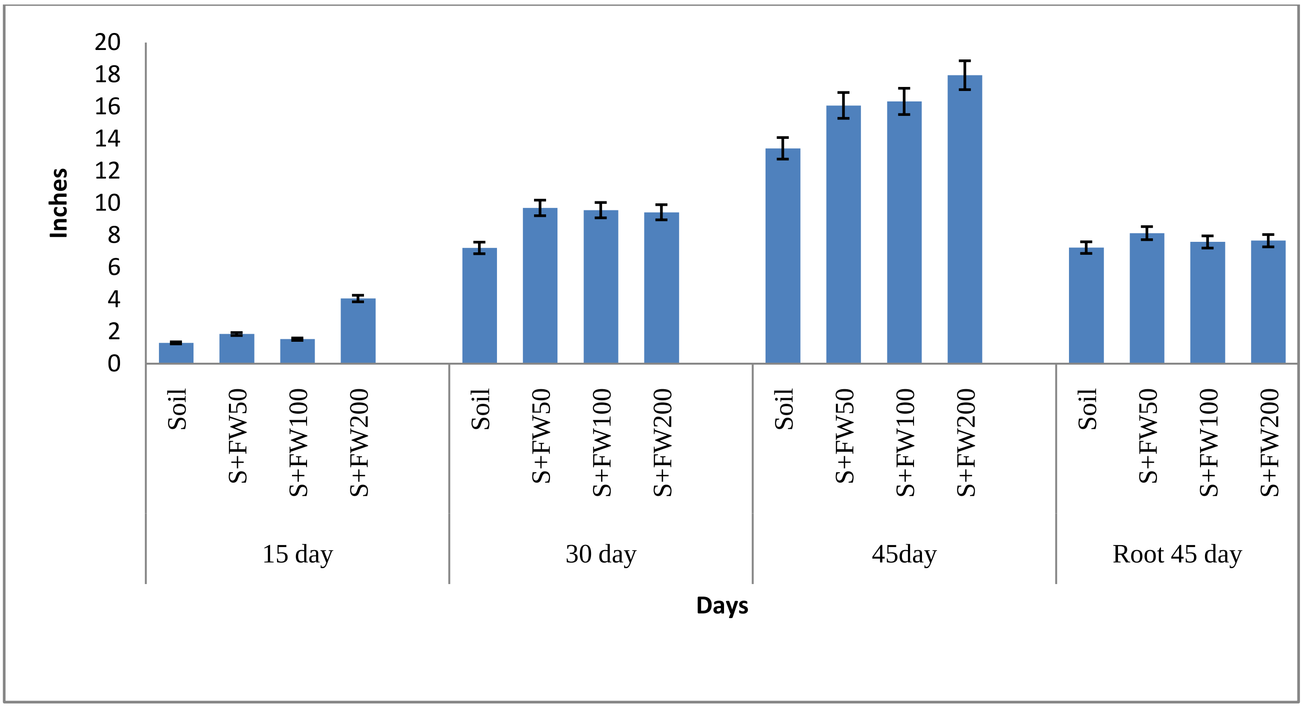

Figure 1: Growth of *Elusine coracana* (Finger millet) measured after addition of different concentration of *Catla catla* fish waste

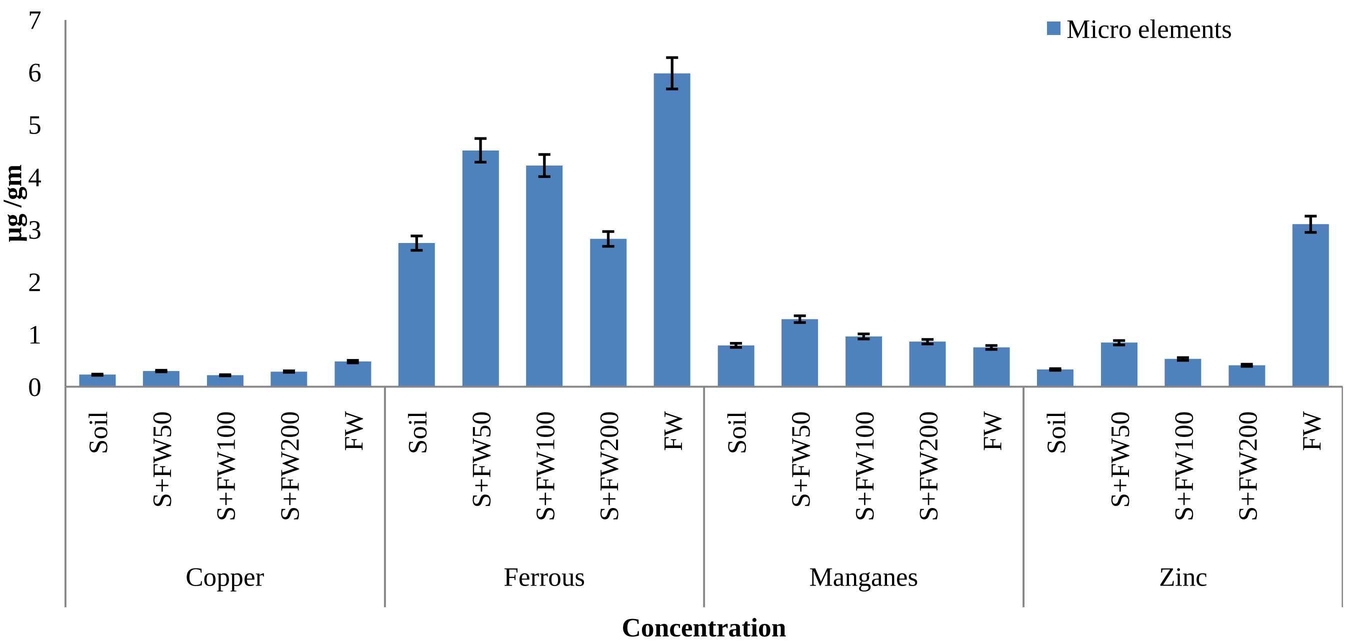

Figure 3: Concentration of micro elements in fish waste and in plant material after addition of different concentration of waste of *Catla catla*

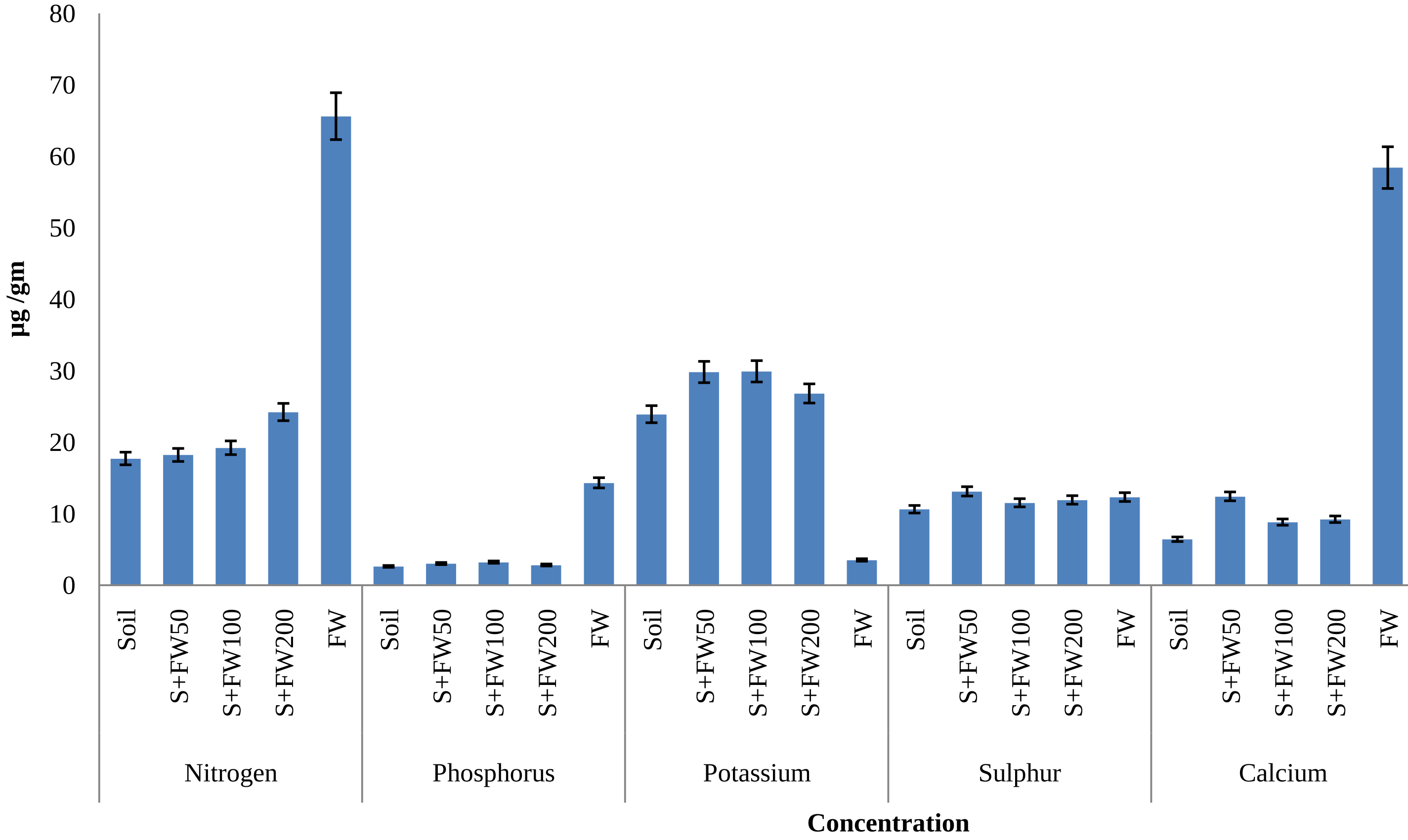

Figure 2: Concentration of nutrients in fish waste and in plant material after addition of different concentration of waste of *Catla catla*