# A COMPARATIVE STUDY OF THE EFFECT OF POTATO FISH FEED AND ORANGE FISH FEED ON GROWTH OF FISHES

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## ABSTRACT

*The study empirically examined the comparative analysis of the effects of potato fish feed and orange fish feed on growth of fishes. This is true because all food processing industries generate waste of varying nature in significant quantities. Managing this waste so as to minimise its impact on the environment is the prime concern. The concept of waste has undergone much change in recent times, with the focus being on utilising waste materials as inputs for the generation of new or reusable products. Vegetable and fruit waste are generated in significant quantities and are easily available at a minimal charge. The comparative utilisation of these wastes as a dietary ingredient was assessed employing the Labeo rohita fingerlings as the test species. The study was conducted over a period of 60 days. Orange peels and potato peels were characterized, and then formulation of orange peel feed (OPF) and potato peel feed (PPF) was carried out. Market common fish feed (CFF) was taken as a control. The three test diets were designated as CFF, OPF, and PPF. Feeding was done once daily. The parameters of the water quality, such as dissolved oxygen, water temperature, pH, total alkalinity, total hardness, calcium hardness, magnesium hardness, and growth response were monitored at fortnightly intervals. The quality of water was maintained by periodic partial replenishment over the period of study. At the termination of the trial, a higher growth response was recorded in the PPF treatment. The initial and final weight and length of fishes was recorded. The results show significant growth in PPF and OPF, with brighter body scales than the other two feed. Fishes were very healthy and normal throughout the study period, indicating no adverse effect on their health. No infection whatsoever was noted during 60 days of the experimental period. One of the recommendations made was that potatoes and oranges should be incorporated into fish feeds in order to reduce the cost associated with the production of farmed fish as a part of efforts to contribute to the alleviation of food insecurity, hunger and poverty.*

**KEYWORDS: Potato Fish Feed, Orange Fish Feed and Growth of Fish.**

## Introduction

Nutrition is one of the major factors in improving the production efficiency of fish. Other factors include these fishes' growth, health, body color, and breeding. Nutritional requirements and feed management needs in fish are determined mainly based on the information obtained and the experience of successful aquarists in the line. Fish feed is the most expensive input during aquaculture operations. The high cost of feed arises from extensive reliance on animal protein sources, such as fishmeal and shrimp meal (Omoregie, 2011). Because of the scarcity and high cost of pelleted feed, the development of low-cost aquaculture systems suitable for small-scale farmers is severely hampered. Therefore, it would be more economical to utilise plant protein in fish feeding than high-cost animal protein materials. Good nutrition and growth in animal production systems are essential to economically producing a healthy and high-quality product.

The use of plant-derived materials as fish feed ingredients is limited by the presence of a wide variety of anti-nutritional substances (Francis, Makkar & Becker, 2007). According to Omoregie and Ogbemudia (2013), fish nutrition has advanced dramatically in recent years with the development of balanced commercial diets to promote optimal fish growth and health. However, as the cost of fish production continues to rise due to soaring feed prices as a result of the extensive use of expensive animal protein such as fish meal, aquaculture production becomes a less profitable or non-profitable enterprise (El-Sayed, 2016). Therefore, it is necessary to explore the use of plant proteins in fish feeds as substitutes for fish growth (Omoregie and Ogbemudia, 2013). Fish meal has become the most essential protein for commercial aquaculture feeds. It provides the fish with high quality protein, an essential amino acid profile, and high palatability (Li, Peterson, Jones, & Robinson, 2016).

## Statement of Problem

Fish feed has been a costly input in aquaculture operations for a long time. Because pelleted feed is scarce and expensive, the development of low-cost aquaculture systems appropriate for small-scale farmers is impeded. As a result, using plant protein rather than high-cost animal protein materials in fish feed would be more cost-effective.

## Conceptual Review

### Concept of Potato

A potato is a perennial, starchy, edible tuberous crop of the nightshade family Solanaceae, Solanum tuberosum L. (Merriam-Webster, 2022). The potato is native to the Peruvian-Bolivian Andes and was domesticated there approximately four to five centuries ago by a species in the Solanum brevicaule complex, and is one of the world's largest food crops (Spooner, McLean, Ramsay, Waugh, & Bryan, 2005). The English term "potato" originates from the Spanish word "patata". The Spanish name is a combination of Taino batata (sweet potato) and Quechua papa (potato), according to the Spanish Royal Academy. The name potato originally referred to a type of sweet potato, although the two plants are not closely related. In many of the chronicles detailing agriculture and plants, no distinction is made between the two (Hai, 2015). This species was described as "bastard potatoes" and "Virginia potatoes" by the 16th-century English herbalist John Gerard, and referred to sweet potatoes as "common potatoes." In the

United States, potatoes are sometimes referred to as "Irish potatoes" or "white potatoes" to distinguish them from sweet potatoes (Simpson & Weiner, 1989).

Potato is one of more than 150 tuber-bearing Solanum species (a tuber is the swollen end of an underground stem). The complex leaves are spirally organised, with a terminal leaflet and two to four pairs of leaflets on each leaf. The length of each leaf is about 20–30 cm (about 8–12 inches). Five fused petals and golden stamens characterise the white, lavender, or purple blooms. The fruit is a small toxic berry with many seeds (Britannica Encyclopaedia, 2022). However, the fickle value of potatoes varies and shifts frequently. It is one of the essential crops in many countries, particularly in eastern and central Europe, where per capita production is still the highest in the world, but it has grown most rapidly in southern and eastern Asia in recent decades. As of 2007, China was the world's largest potato-producing country, and together with India, they are harvesting over a third of the world's potatoes today (Hai, 2015). Furthermore, according to the Britannica Encyclopaedia (2022), potatoes are commonly served whole or mashed as a cooked vegetable and are ground into potato flour, which is used in baking and as a sauce thickener. The tubers are rich in vitamin C, protein, thiamin, and niacin and are highly digestible.

## Concept of Potato Fish Feed

Fresh potato consumption is decreasing in many countries; more potatoes are currently processed into value-added products to meet the demand, especially from the fast food and convenience food industries. Potatoes are usually peeled during processing, either by steam, lye, or abrasive peeling, depending on the type of product. As a consequence, large quantities of peels are generated, which represents a severe disposal problem for the industry, especially with the increasing awareness and aims of minimising environmental impact and sustainability. However, potato peel contains a number of nutritionally interesting compounds and may be used as a key ingredient in fish feed. A growing concern about the high consumption of antibiotics in aquaculture has initiated a search for alternative methods of disease control. Improved resistance against infectious diseases can be achieved by the use of probiotics (Schieber, Stintzing & Carle, 2001).

Potato waste is one of those by-products that remains after potatoes have been processed to produce frozen potato products for human consumption. The total world potato waste is estimated to be 12 million tonnes per year. The potato industry generates lots of waste. One-quarter of what goes into a potato processing plant comes out as waste. Potato peel waste, which constitutes the major portion of the processing waste, represents a severe disposal problem for the potato industry, especially since the wet peels are prone to rapid microbial spoilage. On the other hand, potato peel contains an array of nutritionally interesting components. In view of the growing rejection of synthetic food additives by consumers, functional ingredients obtained from natural resources may be a promising alternative. The utilisation of by-products also contributes to reduced amounts of waste and thus to sustainable production. Therefore, potato peel is highly nutritious and it should not be wasted but should be reused for the production of a few value-added products. One such value-added product is fish feed.

## Concept of Orange

According to Velasco and Licciardello (2014), an orange is a fruit of various citrus species in the family Rutaceae; it primarily refers to Citrus sinensis, which is also called a sweet orange, to distinguish it from the related Citrus aurantium, referred to as a bitter orange. The sweet orange reproduces asexually (apomixis through nucellar embryony); varieties of sweet orange arise through mutations. The orange is a hybrid between pomelo (Citrus maxima) and mandarin (Citrus reticulata) (Andrés, 2013). The chloroplast genome, and therefore the maternal line, is that of pomelo. The sweet orange's entire genome has been sequenced. The orange originated in a region encompassing Southern China, Northeast India, and Myanmar, and the earliest mention of the sweet orange was in Chinese literature in 314 BC. As of 1987, orange trees were found to be the most cultivated fruit trees in the world. Orange trees are widely grown in tropical and subtropical climates for their sweet fruit. The fruit of the orange tree can be eaten fresh, or processed for its juice or fragrant peel. As of 2012, sweet oranges accounted for approximately 70% of citrus production. In 2019, the world produced 79 million tonnes of oranges, with Brazil producing 22% of the total, followed by China and India (Orange Production, 2019).

## Concept of Orange Fish Feed

Fresh fruits are important sources of energy, vitamins, minerals, and fibre. The nutritional value of fruits depends mainly on the quality of these nutrients as well as their quantity. Citrus sinensis is a rich source of vitamins and some minerals (Hornick & Weiss, 2011). According to Ladaniya (2008), citrus belonging to the family Rutaceae is considered a dominant global fruit. Sweet orange (Citrus sinensis) peel is a common by-product (waste) of the food and juice processing industries. Orange peels contain flavonoids, essential oils, and carotenoids. The use of economical, unconventional fish diets and inexpensive feed sources is the main target of fish nutritionists. As a result, the nutrient composition of feed, such as protein, carbohydrate, lipid, vitamins, and minerals, is the most important factor affecting fish health and growth; thus, properly balanced supplemental feeds with a consistent feeding rate can help to improve survival and growth (Dawood & Koshio, 2016). In recent years, plant products (leaf, root, stem, bark, etc.) have been used as natural immune stimulants instead of antibiotics in aquaculture feed formulations due to their eco-friendly and cost-effective properties compared to synthetic drugs. Fruit peels, such as Citrus sinensis, exhibit anti-inflammatory, antitumor, antioxidant, and antimicrobial activities due to the presence of rich flavonoid glycosides, coumarins, β- and ϒ-sitosterols, vitamins, and volatile compounds (Liu, Heying, & Tanumihardjo, 2012). The orange peel is a primary by-product produced by the fruit processing industry, and it accounts for approximately 45% of the total bulk. Citrus sinensis exhibited anticancer, antidiuretic, immunity boosting, and digestive tonic properties. However, to the best of our knowledge, information about the influence of dietary C. sinensis peel extract on fish has not yet been reported. The current study sought to determine the effect of C. sinensis peel extract on the survival, growth, digestive enzyme activities, muscle biochemical compositions, amino acid and fatty acid profiles, and metabolic enzymes of C. catla (Grosso, Galvano, Marventano, Malaguarnera, Bucolo, Drago, & Caraci, 2014).

## Concept of Fish and Fishes

According to Yancey, Gerringer, Drazen, Rowden & Jamieson (2014), fish are abundant in most bodies of water. They can be found in nearly all aquatic environments, from high mountain streams (e.g., char and gudgeon) to the abyssal and even hadal depths of the deepest oceans (e.g., cusk-eels and snailfish), although no species has yet been documented in the deepest 25% of the ocean. With 34,300 described species, fish exhibit greater species diversity than any other group of vertebrates. Fish are an important resource for humans worldwide, especially as food. Commercial and subsistence fishers hunt fish in wild fisheries or farm them in ponds or in cages in the ocean (in aquaculture). They are also caught by recreational fishers, kept as pets, raised by fish keepers, and exhibited in public aquaria. Fish have had a role in culture through the ages, serving as deities, religious symbols, and as the subjects of art, books, and movies. Tetrapods (amphibians, reptiles, birds, and mammals) emerged from lobe-finned fishes, so cladistically they are fish as well. However, traditionally, fish (pisces or ichthyes) are rendered paraphyletic by excluding the tetrapods, and are therefore not considered a formal taxonomic grouping in systematic biology, unless it is used in the cladistic sense, including tetrapods, although usually "vertebrate" is preferred and used for this purpose (fish plus tetrapods) instead. Furthermore, cetaceans, although mammals, have often been considered fish by various cultures and time periods (Greene cited by Wikipedia 1998).

We use the word "fishes" in the broad sense of the word and include four fish and fishlike vertebrate classes: the hagfishes (Myxini), the lampreys (Petromyzontida), the cartilaginous fishes (Chondrich-thyes) and the bony fishes (Actinopterygii) (Nelson 2006). In the Arctic, the four classes have distinct habitat preferences: lampreys are restricted to freshwater for reproduction, hagfishes and cartilaginous fishes are exclusively marine, and bony fishes inhabit all aquatic environments. Genuine freshwater fishes and most diadromous fishes require freshwater for reproduction. Diadromous fishes are those species that undertake regular migrations between freshwater and marine habitats, either for refuge, feeding, or reproduction (McDowall 1992).

## Concept of Fish Growth

According to Almaza´n, Schrama & Verreth (2004), growth is an integrated physiological response encompassing external environmental conditions (food quality and quantity, temperature, water quality) and internal physiological status (health, stress, reproductive state). In other words, growth can also be seen as a characteristic feature of living beings. Every organism grows and attains its normal size. Growth is actually an increase in any dimension of any organism in relation to time. Growth is the process of adding flesh as a result of protein synthesis. The growth of juvenile fishes often correlates with survival. Measures of growth can predict recruitment and may reveal changes or shifts in the ecosystem and habitat in which fish live. Most fishes are visual feeders and require a minimal amount of brink light intensity to develop and grow. However, light intensity was also found to have an effect on swimming activity and feeding, skin color, physiological hormones, and metabolism. Knowledge of fish growth is of vital importance for obtaining a high yield of fish. The rate of growth varies from species to species and sometimes it varies even among species due to many factors such as: different localities; seasonal effects; availability of food and oxygen; population density; age; adaptive character; growth curve; linear growth; and determination of length.

### Effect of Potato Fish Feed and Orange Fish Feed on the Growth of Fishes

As Francis et al. (2007) earlier stated, the use of plant-derived materials as fish feed ingredients is limited by the presence of a wide variety of anti-nutritional substances. Among these are protease inhibitors, phytates, glucosinolates, saponins, tannins, lectins, oligosaccharides and non-starch polysaccharides, phytoestrogens, alkaloids, antigenic compounds, gossypols, cynogens, mimosine, cyclopropenoid, fatty acids, canaranine, antivitamins, and phorbol esters. Omoregie, Igoche, Ojobe, Absalom, and Onusiriuka (2009) supported that protease inhibitors, phytates, antigenic compounds, and alkaloids, at levels usually present in fish diets containing commercially available plant-derived protein sources, are unlikely to affect fish growth performance. However, there is a paucity of information on the utilisation value of potato and orange feed in the nutrition and growth of fish; FAO (1970) in Solomon, Okomoda, and Oloche (2015) revealed that sweet potato peels contain an adequate amount of calories in the form of vitamin B and C as well as a useful amount of other micronutrients such as iron. The carbohydrates in sweet potato peels are highly digestible and soluble. It consists predominantly of starch, with 4–7% occurring as sugar. However, when compared to the amino acid profiles of other crops, the amino acid profile of the potato is found to be deficient in tryptophan and total sulphur (Solomon et al., 2015). It is also moderately high in ascorbic acid, carotene and other vitamins such as thiamine, riboflavin and niacin. Anti-nutritional factors so far identified include phytins, oxalates, and solamines. However, they can be reduced to the barest minimum in feed by processing (Oyin 2006).

### Fish Feed Formulation and Preparation

As stated by Verma and Satyanarayan (2016), waste was collected from several food processing industries. About two kilogrammes of orange and potato peel waste were collected and dried for one week continuously. After 1 week, it was oven-dried and then pulverised to make it into powder form to a size of 250. µ. The powder was used as media to grow the probiotics. The pure culture of probiotics was inoculated into the filtrate used as media in sterile conditions and incubated at 37°C for 24 hrs. After 24 hrs, growth was observed. Calcium carbonate was used to immobilise the probiotic spores grown in media. Experimental diet contained 4% potato peel powder or 4% orange peel powder, 4% calcium carbonate blended with probiotics, and 2% starch as a binder. The ingredients were the same for both feeds, except orange peel was used in orange peel feed (OPF) and potato peel was used in potato peel feed (PPF). Market common fish feed (CPF) was considered as a control.

### Experimental Setup

Verma and Satyanarayan (2016) also stated that the experiment was conducted over a period of 60 days. The fingerlings of Labeo carps (Ham.) were obtained from Futala Lake, Nagpur, Maharashtra. Labeo rohita fingerlings are selected because of their high nutritional value and easy availability. The experiment was set up in three distinct experimental groups, each group having three replicates, in 09 uniform size glass aquariums (20 L capacity each). Each of the aquariums was stocked with 10 fingerlings. Initial length and weight was recorded before loading of fingerlings in experimental aquarium. Round the clock aeration was provided to all the tubs, with a 2 HP air blower. Prior to feeding of experimental diets, the fish were acclimatised and starved overnight to empty their guts and increase their appetite and reception of new diets. The fish were fed (5% body weight) twice daily at 10.00 and 20.00 h. As the water becomes turbid, water was changed every second day to maintain good water quality and dissolved oxygen content.

Experimental tubs were cleaned manually by syphoning all the water along with faecal matter and left over feed daily. The syphoned water was replaced by an equal volume of fresh, chlorine-free tap water. Water quality was monitored using a standard method for temperature, pH, alkalinity, dissolved oxygen, total hardness, calcium hardness, and magnesium hardness.

After 60 days of experimentation, the fish were removed from the aquarium and their final length and weight were noted. Then, they were dissected to remove muscle tissue and liver, which are nutritious and edible. Tissues like muscle and liver are separated from the bones and cleaned by dabbing them on filter paper to remove excess water. Thus obtained, tissues were weighed and processed for protein content (Verma & Satyanarayan, 2016).

***Nutritional indices***: The growth response of fish fed with different diets was monitored by noting average gain in weight and length

***Average gain in weight***: It gives the increase in weight of the animals during the experimental period. It was calculated using the formula.

Average gain in wt. (g) = Average Final wt. (g)—Average Initial wt. (g)

***Average gain in length***: This gives the increase in standard length during the experimental period. It was calculated using following formula.

Average gain in length (cm) = Average Final length (cm)—Average Initial length (cm)

## Estimation of Protein

Protein Estimation using Lowry's Method. This assay was introduced by Lowry et al. It is highly sensitive and can detect protein levels as low as 5 µg/ml. This is the most widely used method for protein estimations.

## Statistical Analysis

The experiment was designed in a completely randomized block design with three replications for each treatment. On termination of the experiment, all surviving fishes were collected and length and weight recorded individually. All statistical analysis was performed using IBM SPSS Statistics version 20.

## Results / Discussion

**Table 1: Peel characterization carried out before feed preparation**

| Sr. no. | Parameters | Potato peel | Orange peel |
|---|---|---|---|
| 1 | Protein | 4.12 g | 1.5 g |
| 2 | Carbohydrate | 14.2 g | 1.5 g |
| 3 | Fat | 0.79 g | 0.02 g |
| 4 | Total dietary fibre | 2.9 g | 10.6 g |
| 5 | Calcium | 31 mg | 97 mg |
| 6 | Iron | 3.3 mg | 0.8 mg |
| 7 | Potassium | 417 mg | 212 mg |
| 8 | Sodium | 8.7 mg | 0.2 mg |

According to Verma and Satyanarayan (2016), before initiating the experiment, the peel of potato and orange are characterized (Table 1). The results show high content of carbohydrate (14.2 g) and proteins (4.12 g) followed by minerals, that is potassium (417 mg) in potato peels. Whereas in orange peel, it shows high calcium and fibre content. After peel characterization, it was processed for preparing PPF and OPF. The proximate nutritional values of experimental feed were depicted in Table 2. The percentage of moisture is slightly variable, that is 10.3 and 9.5% in PPF and OPF, respectively, whereas the ash content is higher in PPF (32.75%) than in OPF (12.4%). In PPF, protein content (63.98%) is highly followed by carbohydrate (14.2%), fat (8.2%), total dietary fibres (3.65%) and total nitrogen. While in OPF, total dietary fibres possess high content, that is (38.12%) followed by protein (12.6%), carbohydrate (12.6%), fat (2.8%) and total nitrogen (0.41%).

**Table 2: Proximate nutritional values of experimental feed.**

| Sr. no. | Parameters | PPF (%) | OPF (%) |
|---|---|---|---|
| 1 | Ash | 32.75 ± 0.4 | 12.4 ± 0.5 |
| 2 | Moisture content | 10.3 ± 0.7 | 9.5 ± 0.6 |
| 3 | Total nitrogen | 0.52 ± 0.4 | 0.41 ± 0.6 |
| 4 | Fat | 8.2 ± 0.1 | 2.8 ± 0.4 |
| 5 | Carbohydrate | 14.2 ± 0.2 | 12.6 ± 0.3 |
| 6 | Total dietary fibres | 3.65 ± 0.8 | 38.12 ± 0.5 |
| 7 | Protein | 63.98 ± 0.2 | 21.01 ± 0.3 |

**Each value is mean ± SD of triplicate observations**

As stated by Verma and Satyanarayan (2016), the water quality during the study period remained in following range: pH 7.4–8.4, alkalinity 140–170 mg/l, dissolved oxygen 6.8–8.0 mg/l, total hardness 120–160 mg/l, calcium hardness 32–53 mg/l and magnesium hardness 6.5–9.4 mg/l. Since fish are poikilotherm, water temperature plays an important role in energy partitioning, protein assimilation and growth. Water temperature was varied from 28 to 30°C. All the water quality parameters were within the permissible limit. However, the recommended values are: pH: 6.7–9.5; alkalinity: 50–300 mg/l; dissolved oxygen: 5–10 mg/l and total hardness: 30–180 mg/l.

During experimental period, morphological and behavioural characteristics of fish were observed. Fishes were swimming actively throughout the entire tank, not just hanging out or laying at the bottom. They consume the fish feed regularly and swim to the surface quickly during feeding time. Fish do not show any white spots or blemishes on their body; fins were not torn, curved or ragged, and eyes were not bulged. Gill movements were very normal and controlled. Fish showed no stomach bulging or fin curving indicating that they were healthy and the feed was not toxic and can be used in aquaculture.

**Table 3: Growth performance of Labeo rohitafed different test diet treatments.**

| Treatments | Experimental groups | | |
|---|---|---|---|
| | CFF | PPF | OPF |
| Initial length (cm) | 7.4 ± 0.65 | 8.1 ± 0.07 | 7.5 ± 0.38 |
| Final length (cm) | 14.6 ± 0.36 | 16.0 ± 0.13 | 14.7 ± 0.51 |
| Length gain (cm) | 7.2 ± 0.62 | 7.9 ± 0.05 | 7.2 ± 0.14 |
| Initial weight (g) | 6.7 ± 0.20 | 7.1 ± 0.08 | 6.2 ± 0.24 |
| Final weight (g) | 23.9 ± 0.39 | 26.3 ± 0.12 | 23.0 ± 0.06 |
| Weight gain (g) | 16.2 ± 0.56 | 19.2 ± 0.07 | 16.8 ± 0.29 |

**Each value is mean ± SD of triplicate observations.**

According to Verma and Satyanarayan (2016) the mean weight gain of Labeo rohitain the three treatments CFF, PPF and OPF was found to be 16.2, 19.2 and 16.8 g, respectively. The highest average live weight gain was found to be obtained in treatment PPF. The average gain in length of Labeo rohitain the three treatments CFF, PPF and OPF was found to be 7.2, 7.9, and 7.2 cm, respectively. The highest average gain in length was obtained in treatment PPF.

According to Sunitha and Rao (2003), better weight gains in Tilipia mossambica were achieved when fed with blue green algae (Chlorella, Anabaena, Oscillatoria, and Nostoc) grown with the support of mango waste. Hung et al. also reported that pangas catfish (Pangasius pangasius) has been demonstrated to have a capacity for utilising plant feedstuff carbohydrates for energy. Therefore, it can be concluded that vegetable wastes have considerable potential for partial replacement with fish meal as supplementary feed ingredients in the sustainable aquaculture of Labeo carps.

Feed is the single largest item of expenditure for the farmers, accounting for 79–92% of the total production cost in striped catfish (Platydoras armatulus) farming. In general, two types of feeds are used for striped catfish: wet farm-made feeds and pelleted feeds, and these differ in formulation and quality. According to NRC (2011), the traditional feeding of small-scale catfish farming is largely based on trash fish (marine origin), constituting approximately 50–70% of feed formulations. Pangas catfish have been demonstrated to have a capacity for utilising plant feedstuff carbohydrates for energy, but little research has been performed on these fish species with regard to alternative dietary protein source selection. Using plant-based proteins in aquaculture feeds requires that the ingredients possess certain nutritional characteristics, such as low levels of fibre, starch, and anti-nutritional compounds. They must also have a relatively high protein content, a favourable amino acid profile, high nutrient digestibility, and reasonable palatability. A number of previous studies discuss the suitability of plant protein feeds and/or local agricultural by-products as an alternative protein source in fish feeds (Nyina-Wamwiza, Wathelet, Richir, Rollin & Kestemont, 2010).

## Conclusion

It is clear that these feeds are very nutritive and help in the growth of fish. There appeared to be no adverse changes morphologically. Instead, the fish showed very healthy growth with bright body scales. It is clear from the study that feed prepared for fish is non-toxic and has good nutritive value due to orange and potato peel waste. There appeared to be no adverse changes morphologically. Comparative studies between CFF, PPF, and OPF showed that PPF is very nutritive and helps in the qualitative and quantitative growth of fish. While in OPF and CFF, growth is slow. But Labeo rohitafed with OPF showed brighter body scales than the other two. Fishes were very healthy and normal throughout the study period, indicating no adverse effect on their health.

## Recommendations

1. Potatoes and oranges should be incorporated into fish feeds in order to reduce the cost associated with the production of farmed fish as a part of efforts to contribute to the alleviation of food insecurity, hunger and poverty.
2. It is quite obvious that potato and orange and valuable food types for fish, they should not be wasted but should be reused for the production of few value added products such as food supplement in boosting the growth, dynamism and sustainability of fish.

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