Strategies to enhance the utilization of cotton seed meal in aquafeed

Dr. Manish Jayant, Scientist

Fish Nutrition, Biochemistry and Physiology Division,

ICAR- Central Institute of Fisheries Education, Mumbai- 400061

Introduction

- Indian farmers grow all four varieties of cotton (Blaise and Kranthi, 2019)
  - ✓ *Gossypium arboreum,*
  - ✓ ***Gossypium herbaceum,***
  - ✓ *Gossypium hirsutum, and*
  - ✓ *Gossypium barbadense*

- In India, majority of the cotton production comes from ten major cotton growing states, which are grouped into three diverse agro-ecological zones, as under:-
  - ✓ Northern Zone - Punjab, Haryana and Rajasthan
  - ✓ Central Zone - Gujarat, Maharashtra and Madhya Pradesh
  - ✓ Southern Zone - Telangana, Andhra Pradesh, Karnataka and Tamil nadu

- India is having 1st place in the world with estimated production of **362.18 lakh bales i.e.** 23% of world cotton production of 1555 lakh bales (Source: Ministry of Textiles).
- India is also the **2nd largest consumer** of cotton in the world with estimated consumption of 338 lakh bales i.e. 22% of world cotton consumption of 1507 lakh bales (Source: Ministry of Textiles).

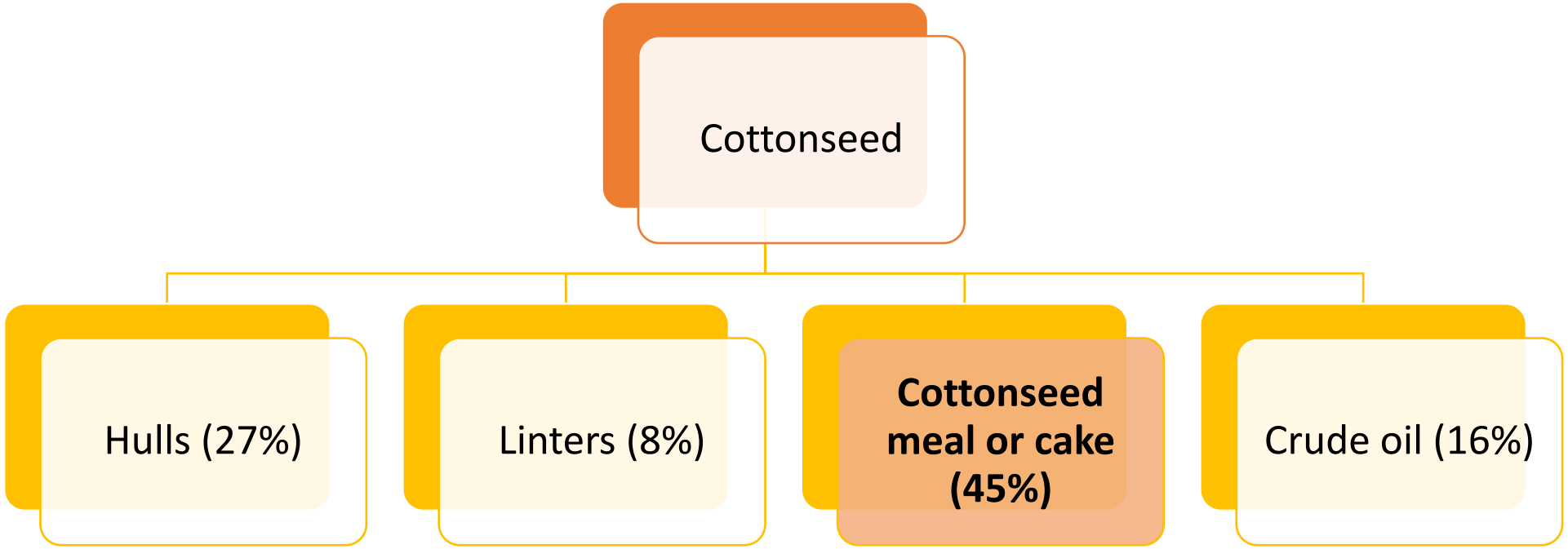
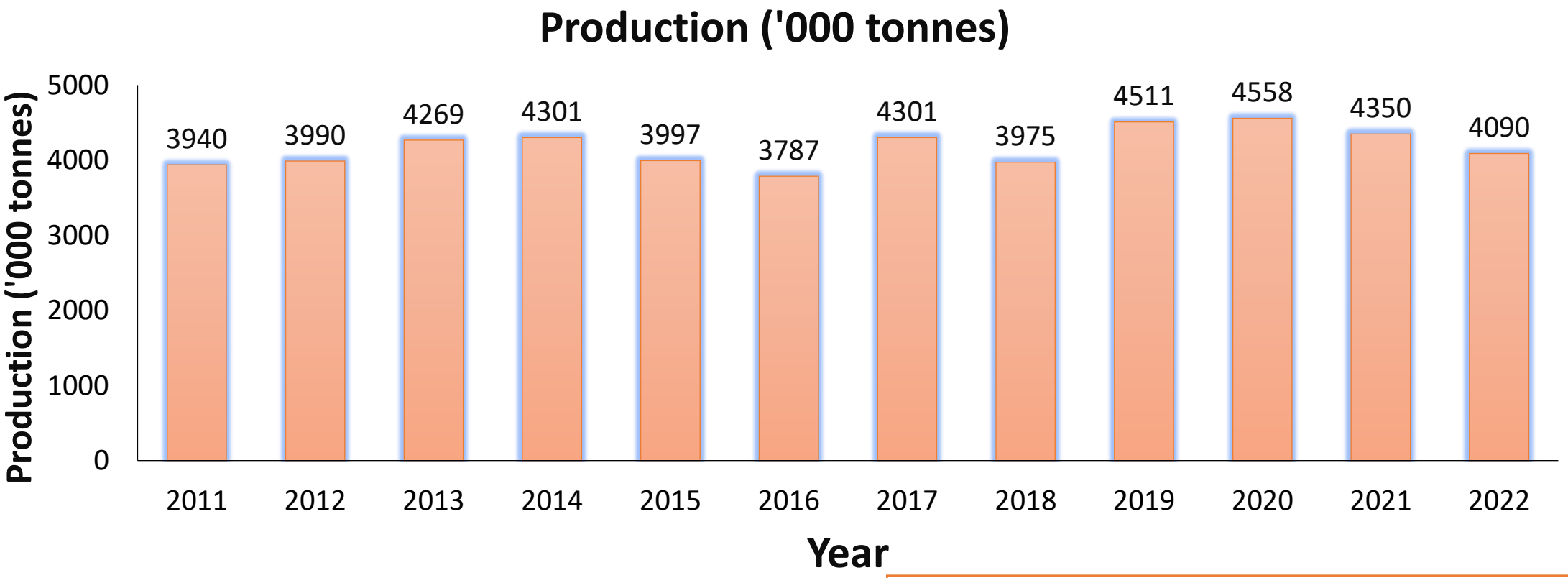


Chart- Composition of cottonseed (He et al., 2022)

Cotton seed meal production in India



Source: United States Department of Agriculture

https://www.indexmundi.com/agriculture/?country=in&commodity=cottonseed-meal&graph=production

Table 1: Proximate analysis and chemical composition of cotton seed meal (CSM) and soybean meal (SBM)

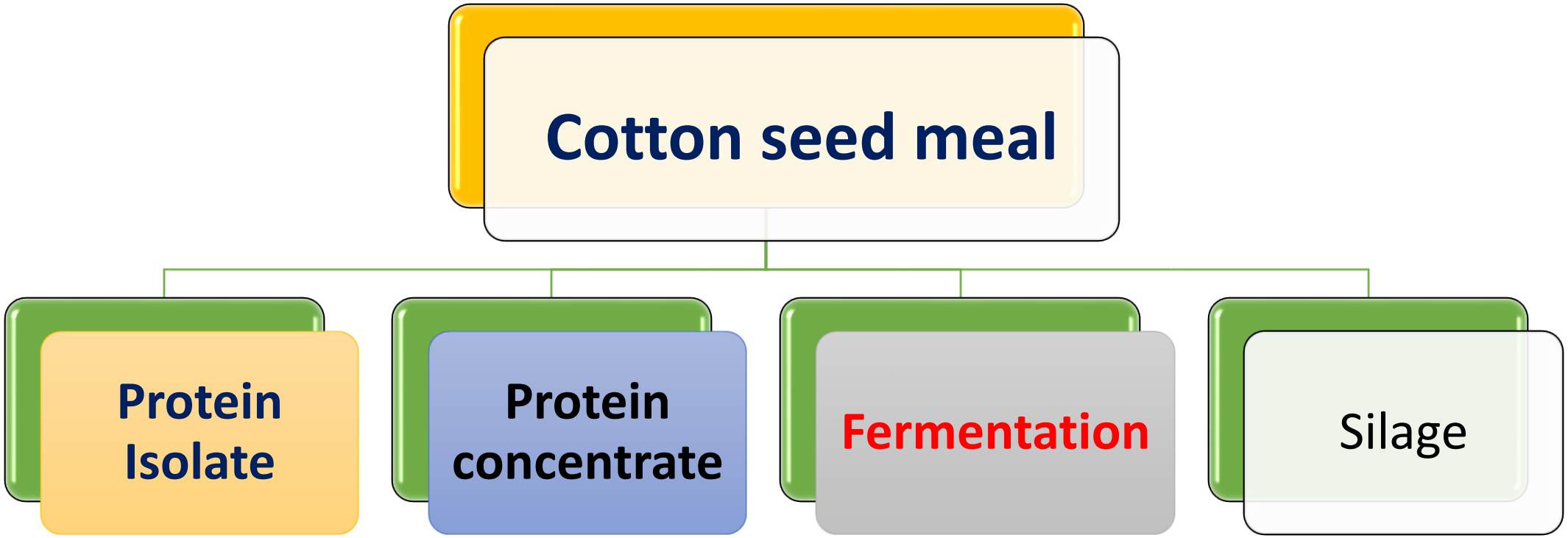
Variables	CSM	SBM
Crude protein	39.02	42.42
Ether extract	3.07	1.80
Ash	7.15	6.05
Crude fiber	11.92	7.54
Free gossypol	0.40	ND
Dry matter	89.86	88.50

(Source: Thirumalaisamy et al., 2016; Yu et al., 2020)

Amino acids	CSM	SBM
Lysine	21.3	29.2
Methionine	5.60	6.50
Cystine	6.40	7.30
Threonine	14.5	18.2
Arginine	49.8	34.3
Isoleucine	15.2	21.1
Leucine	26.8	35.2
Valine	21.5	22.6
Histidine	12.6	12.1
Phenylalanine	24.3	23.3

(Source: Tang et al., 2012)

Strategies: Utilization of cotton seed meal



Why Protein Isolate?

Cotton seed meal

- Contain high level of fibre and less protein content
- Contain large amount of indigestible material and anti-metabolites, which are major problem in plant based feed ingredients.
- Protein extraction is one of the best method to make the plant ingredients into a better utilizable products for fish optimum nutrient utilization.

Protein concentrate/ isolate

- One way of reducing some ANFs and toxic components (Marrufo-Estrada et al., 2013)
- Contain high levels of protein (more than 1.5-3.0 fold increase), which often have digestibility similar or higher than that of fishmeal protein (Makkar et al., 2008; Nepal et al., 2010).
- Protein concentrates/ isolates are enriched in total proteins and have low amounts of lipids, soluble carbohydrate, phenols or fibers.
- Using plant protein isolate as protein source will ensure a healthier animal , nutrient utilization & better growth performance compared to using raw seed cake directly as protein source in fish diets (Kaushik et al., 1995; Kumar et al., 2011).

Preparation of cotton protein concentrate

Isoelectric point precipitation method

Alkaline solubilisation of proteins followed by precipitation at isoelectric pH

Grind cotton seed meal in a grinder

Filter it using a 0.5 mm sieve and store in an air tight container

Defatted cotton seed meal + Distilled water (1:15 w/v)

Adjust pH 12.0 with 1 N NaOH

Continue to make up the pH 12.0 for 30 min

Keep it for continuous stirring (2 hour) at room temperature

Centrifuge the slurry @ 7000 rpm for 15 min (4°C)

Collect the supernatent & adjust the pH at 4.5 with HCl to precipitate the protein

Centrifuge the precipitated protein @ 7000 rpm for 10 min(4°C)

Discard the supernatent and wash the pellet with distilled water twice @ 7000 rpm for 5 min

Collect the pellet in petriplate and freeze dry it for 24 hour

Cotton seed protein concentrate

Cotton seed meal

Grinded cotton seed meal

Cotton protein concentrate

Table 2 : Proximate Analysis of cotton seed meal and cotton protein concentrate (% dry weight basis)

Variable	CSM	CPI
Moisture	17	0
Dry matter	83	100
Crude protein	40	68
Ether extract	10	5
Crude Fibre	10.5	3.4
Total ash	7.1	3.0
Nitrogen free extract	32.4	20.6

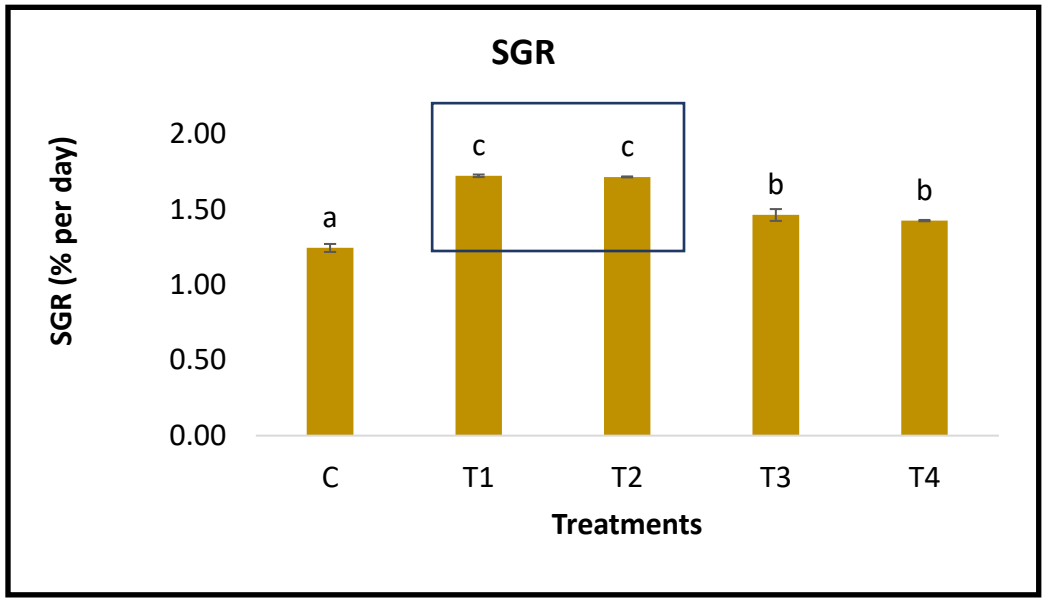
Dry matter recovery- 31.45 %
Protein recovery- 53.46 %

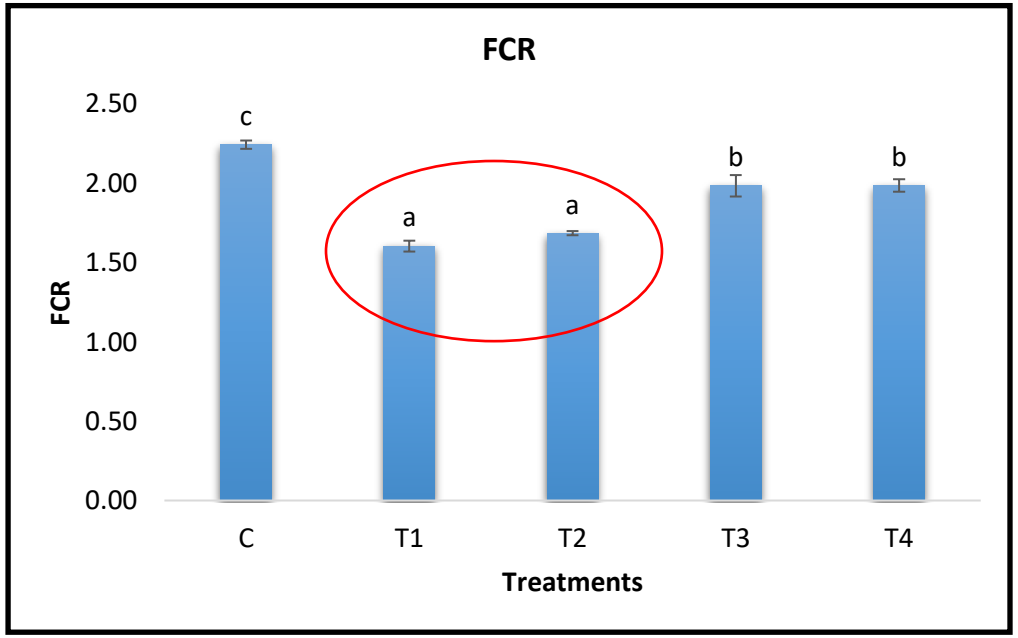
Table 3: Feed Formulation of the experimental diet fed to *Pangasianodon hypophthalmus* fingerlings

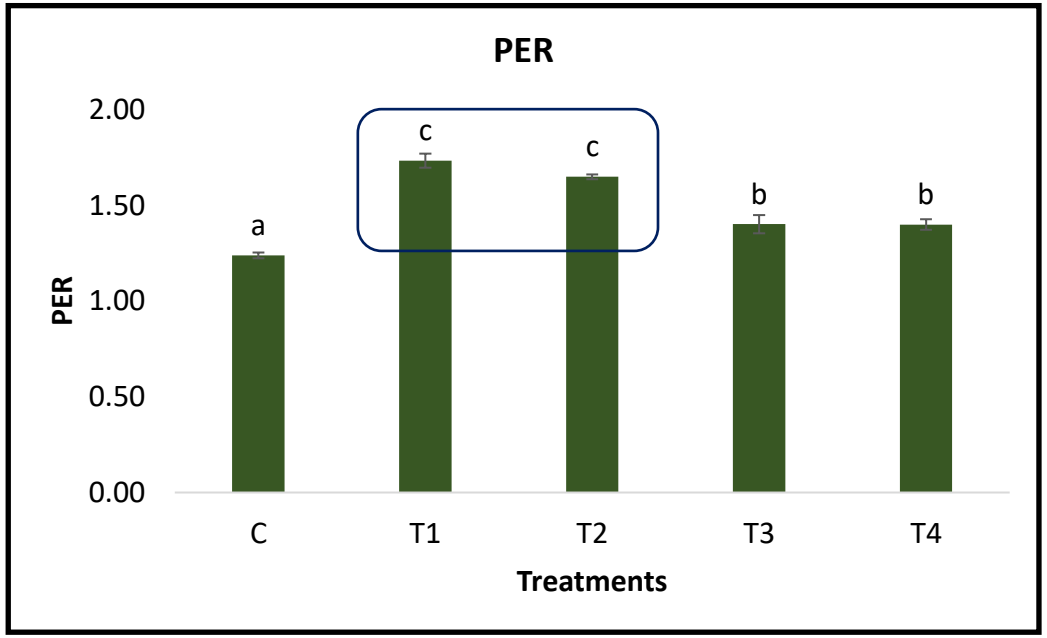
Ingredients	C	T1	T2	T3	T4
Fish meal [a]	12.00	12.00	12.00	12.00	12.00
Soybean meal[c]	30.00	22.50	15.00	7.50	0.00
Cotton protein concentrate[b]	0.00	5.00	10.00	15.00	20.00
Mustard oil cake [a]	10.00	10.00	10.00	10.00	10.00
Groundnut oil cake [a]	15.00	15.00	15.00	15.00	15.00
Corn flour [c]	11.50	13.00	14.00	15.50	17.00
Wheat flour [a]	13.46	14.46	15.96	16.96	17.96
Fish oil [a]	1.00	1.00	1.00	1.00	1.00
Sunflower oil [a]	4.00	4.00	4.00	4.00	4.00
*Vitamin- min premix [a]	2.00	2.00	2.00	2.00	2.00
Choline chloride [a]	0.02	0.02	0.02	0.02	0.02
Butylated hydroxyl toluene [a]	0.02	0.02	0.02	0.02	0.02
Carboxymethyl cellulose [a]	1.00	1.00	1.00	1.00	1.00
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

[a]Fish nutrition, Biochemistry and Physiology Laboratory, ICAR-Central Institution of Fisheries Education, Mumbai, India
[b]Prepared in Fish nutrition, Biochemistry and Physiology Laboratory, ICAR-Central Institution of Fisheries Education, Mumbai, India
[c]Purchased from local grocery store, Mumbai, India
*Composition of vitamin mineral mix (Agrimin) (quantity/kg): Vitamin A- 55.00.000 IU; vitamin D3- 11,00,000 IU; vitamin B2- 2,000 mg; vitamin E- 750 mg; vitamin K-1,000 mg; vitamin B6- 1,000 mg; vitamin B12-6 mcg; calcium pantothenate-2,500 mg; nicotinamide-10 g; choline chloride- 150 g; Mn- 27,000 mg; 1- 1,000 mg; Fe- 7.500 mg; Zn- 5,000 mg; Cu-2,000 mg; Co-450; L-lysine-10 g; DL-methionine- 10 g; selenium-125 mg.

Growth performance and nutrient utilization







Thank you